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AN EXPERIMENTAL COMPARISON OF DIRECT-DETAILED AND DIRECTED DISCOVERY METHODS OF PRESENTING TAPE-RECORDED INSTRUCTION.

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EFFECTS ATTRIBUTABLE TO DIRECT-DETAILED AND DIRECT DISCOVERY METHODS OF ORGANIZING AND PRESENTING TAPED (AURAL) INSTRUCTION WERE COMPARED. INITIAL LEARNING, RETENTION, AND TRANSFER OF TRAINING WERE MEASURED. DIRECTED DISCOVERY, DIRECT-DETAILED METHODS, AND A SINGLE CONTROL WERE THE INDEPENDENT TREATMENT VARIABLES. HIGH, AVERAGE, AND LOW ABILITY GROUPS WERE THE INDEPENDENT LEVEL VARIABLES. INITIAL LEARNING, RETENTION, AND TRAINING TRANSFER AT STIPULATED INTERVALS WERE DEPENDENT VARIABLES. LENGTH OF INSTRUCTION, TYPE OF AIDS, WORKBOOK PROBLEMS, TESTS AND TESTING CONDITIONS, AND INSTRUCTION CONTENT AND METHODS WERE CONTROLLED VARIABLES. FEMALE, FIRST-SEMESTER COLLEGE STUDENTS IN A REQUIRED SOCIAL SCIENCE COURSE WERE THE SUBJECTS. ORTHOGRAPHIC PROJECTION SKILLS AND PRINCIPLES WERE SELECTED FOR THE LEARNING TASK. TWO GROUPS OF SUBJECTS RECEIVED TREATMENTS. A CONTROL GROUP RECEIVED NO INSTRUCTION. TESTS FOR INITIAL, TRANSFERRED, AND RETAINED LEARNING WERE THEN ADMINISTERED AND COMPARED. THE AUTHOR CONCLUDES THAT EFFECTIVE LEARNING CAN BE ACCOMPLISHED WITHOUT THE PRESENCE OF A TEACHER. (WN)

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John D. Rowlett, Professor
Industrial Arts Department
Eastern Kentucky State College
Richmond, Kentucky

Title VII Project Number 629
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INTRODUCTION

Orientation to the Problem

The unprecedented increases in college and university enrollment forecast for the years ahead pose serious problems for those responsible for administering institutions of higher learning and for students who will seek instruction at such institutions. On the one hand the sheer number of students who are likely to seek a higher education is almost overwhelming; on the other hand the probability of a proportionate increase in highly competent staff members to meet this demand is, at the present, not at all encouraging. Although many plans have been proposed, and in fact are in operation, to attract an increasingly larger number of capable people to careers in higher education, it seems feasible that colleges and universities might well assay the utilization of their present faculties to determine whether or not the knowledge and skills of well-trained staff members can be made available to larger numbers of students than is normally the case. The limitations of class sizes coupled with a reasonable teaching assignment restrict the contact of many outstanding professors to small groups of students, groups that may be unnecessarily small if new instructional media are employed.

A distinct possibility for more effective staff utilization involves the use of taped instruction. Not only does this procedure seem feasible from the standpoint of providing an opportunity for the employment of tapes, prepared by outstanding scholars for introductory and/or supplementary treatment of a given topic, it also seems appropriate in regard to the organization of key presentations, prepared by the individual instructor, and intended for his own classes. In addition, such instruction could be made available for repetition for those students who may have difficulty understanding an initial presentation. Furthermore, the use of taped instruction seems to have unusual possibilities for independent study in a wider range of subjects than those in which it is currently employed.

The educational applications of taped instruction enumerated above are by no means exhaustive. Similarly, no implication is intended in regard to the efficacy of taped instruction in contrast with other media that might be employed. However, if it is reasonable to assume that taped instruction has merit in a wide range of educational settings, then it follows that the unique features of the teaching-learning process inherent in this approach ought to be studied and evaluated.

One of the more obvious problems involved in preparing taped instruction relates to the technique of structuring the material to be learned. The methods employed in organizing and presenting taped instruction may determine to a large extent the quality of initial learning and the degree to which students retain and transfer the facts and principles they learn. Logically, such methods should be grounded in principles of learning that have been established in the psychological laboratory and that have been experimentally tested in the classroom. A number of research studies (1, 2, 3, 4, 6, 11, 12, 13, 14, 16, 26, 27, 28, 29) have been designed to evaluate instructional methods in terms of initial learning, retention, and transfer. Instruction related to the learning task in each of these studies, however, was presented by the experimenter using media other than tape recordings.

Statement of the Problem

The purpose of this study is to provide formal research evidence as to the effectiveness of two selected methods of organizing tape-recorded instruction as measured by 1) initial learning, 2) retention, and 3) transfer in a learning situation involving problem solving with meaningful materials. The experiment is designed, in addition, to test for interaction between methods and high, average, and low ability levels. Orthographic projection principles and skills, a fundamental unit of work in mechanical and engineering drawing, will serve as the learning task. College women who have completed the first semester of the freshman year at Eastern Kentucky State College will serve as subjects.

Theoretical Bases of Methods

Learning theories and experimental investigations, based either implicitly or explicitly on these theories, may place the discriminating teacher in a dilemma in regard to selecting principles of organization for taped instruction. While the more sophisticated learning theories provide sufficient bases for preparing instruction, the organizational patterns, depending on the theories selected for guidance, may differ to a marked degree. This study will be concerned with evaluating the quality of learning that occurs under conditions where two organizational patterns of taped instruction are employed, each inferred from a selected learning theory.

Direct-Detailed. One may find theoretical support for a method of organization that involves highly direct and detailed instruction. This method has its basis in the learning theory of Edward Lee Thorndike (30, 31, 32, 33) and to a lesser extent in Guthrie's (8, 9, 10) system of contiguous conditioning. In discussing methods of teaching arithmetic, Thorndike points out: (32, p. 59) "Time spent in understanding facts and thinking about them is almost always saved doubly by the greater ease of memorizing them." In suggesting that a teacher should employ a direct method of instruction, Thorndike states: (33, p. 147)

> The attainment of active rather than passive learning at the cost of practice in error may often be a bad bargain. Refusal to supply information on the ground that the learner will be more profited by discovering the facts by himself runs the risk not only of excessive time cost but also of strengthening of wrong habits. The learner's self-punishment when he makes a mistake may sometimes be no better than the punishment in our experiments. The almost universal tolerance of imperfect learning in the early treatment of a topic, leaving it to be improved by gradual elimination of errors in later treatments, is probably unsound and certainly risky. What removes errors in later treatments is the rewarding of the right connections, and such rewarding might better be put to work earlier.

In terms of Thorndike's theory neural "bonds" are formed when a response to a stimulus produces a satisfying consequence for the learner. Satisfying consequences may be the end-result of praising the student's efforts for a job well-done, of simply telling him that he is "correct" when a problem is properly solved, or in the case of sub-human subjects, of rewarding, with food, a cat that has found its way out of a puzzle box. Guthrie's theory of contiguous conditioning omits reward, as this term is generally employed, as a necessary factor in learning. Response patterns simply become associated with stimuli when they occur at the same time.

Explicit in the theories of Thorndike and Guthrie is the conviction that the responses to be practiced by learners should be those and only those that are correct for a given pattern of stimuli. Otherwise, inappropriate responses may become associated with stimuli for which other responses would be correct. Organization based on these learning theories would seem to demand careful and detailed instruction to insure the formation of desired connections between stimuli and responses. It seems to follow that instruction relative to principles and generalizations would be presented in a detailed manner and that these would be illustrated by showing their applications to the solution of problems. Provisions for students to discover the application of principles ~~in~~ problem solving would be unsound in view of the fact that incorrect applications might occur.

Directed-Discovery. A second method of organization has its theoretical basis in the learning theories and experiments of gestalt psychologists such as Kohler, (19, 20, 21) Koffka, (18) Katona, (16) Luchins, (22) and Wertheimer (35). Whether one considers the experiments of Kohler with sub-human subjects or those of the latter three psychologists, whose studies involved school children and adults, one striking commonality exists: learning is regarded as a problem solving process involving insight as a phase of the process and, at least in terms of human subjects, understanding as the end result. The learning situation is such that if the subject responds to the problem, a degree of tension is produced that persists until the problem is solved or until considerable time has elapsed. Wertheimer explains the gestalt position in the following manner: (35, p. 195)

> When one grasps a problem situation, its structural features and requirements set up certain strains, stresses, and tensions in the thinker.

> What happens in real thinking is that these strains and stresses are followed up, yield vectors in the direction of improvement of the situation, and changes it accordingly.

Although gestalt learning theory is neither as concise nor as inclusive as Thorndike's system, it seems to follow that, in terms of instruction, the learning task should be, to the extent possible, within a problem solving context. Gestalt psychologists have emphasized that students develop a better understanding of principles if, through their own effort, they share in the discovery of their meaning and applications. Obviously, many principles are too difficult and complex to expect students to comprehend without assistance. From the gestalt point of view, this assistance takes the form of questions and "hints" that guide the student's efforts but does not reduce the level of tension deemed necessary for effective learning.

Related Research

A great deal of formal research involving one or more dimensions of the present study has been completed in recent years. Four studies relate specifically to the current project. Each employed 1) a comparison of direct-detailed and directed discovery methods; 2) taped instruction, 3) a meaningful learning task; and 4) tests of initial learning, retention, and transfer. In addition, the studies were designed to test for interaction between methods and ability levels.

Ray's (24) comparison of a direct and detailed and a directed discovery method of teaching micrometer principles and skills involved the use of taped instruction keyed to a series of 35 mm. slides. Ray used ninth grade students as the subjects in this experiment. Ray found that the two groups receiving differential treatments did not differ significantly in terms of initial learning, nor did they differ in performance on a retention test administered one week after treatment. However, the group receiving directed discovery instruction was superior on transfer tests administered one and six weeks after treatment and on a six weeks retention test. Ray found no evidence of interaction between teaching methods and ability levels. The low ability subjects seemed to profit as much, in terms of their limitations, from the directed discovery method as the high ability group.

Rowlett's (25) study contrasted a direct-detailed with a directed discovery method of teaching orthographic projection principles and skills to ninth grade subjects. Forty-nine minutes of taped instruction was related to a workbook illustrating the principles under consideration and to problems which were solved by the subjects. Using a treatments x levels x sex design, Rowlett found no difference between the two groups on a test of initial learning. However, the subjects receiving the directed discovery instruction were superior on retention and transfer tests administered twelve days and six weeks after instruction. Rowlett found no evidence of interaction between ability levels and methods.

Grote's (7) comparison of direct-detailed and directed discovery methods of teaching principles of mechanics produced results inconsistent with those of Ray and Rowlett. Grote utilized two instructional sessions of thirty-nine and thirty-eight minutes, spaced eight days apart. All instruction was taped. He found that the subjects receiving direct-detailed instruction were superior on the test of initial learning following the first instructional period. However, no significant differences were found between the groups on the initial learning test following the second instructional period or on retention and transfer tests administered one and six weeks after treatment.

Grote also compared the performance of a group receiving direct-detailed instruction during the first instructional period followed by directed discovery instruction during the second period with a group receiving the two methods in the reverse order. He found significant differences favoring the directed discovery followed by direct-detailed instructional sequence on 1) a test of initial learning following the second instructional period, 2) a test of retention administered six weeks after treatment, and 3) a transfer one week test. In addition, Grote found evidence of interaction between methods and ability levels on the second initial test and on test of retention administered one and six weeks after treatment.

Moss (23) found no significant differences between subjects receiving direct-detailed and directed discovery methods of teaching letter press imposition as measured by a test of initial learning and retention and transfer one and six weeks tests. In addition, Moss found no evidence of interaction between methods and ability levels. The subjects, vocational-industrial high school students in their junior and senior years, received forty-seven minutes of taped instruction.

The four studies cited above investigated the quality of initial learning, retention, and transfer that occurs when instruction is organized and taped on the basis of direct-detailed in comparison with a directed discovery method. The inconsistencies in the findings, particularly those of Grote and Moss in contrast to the results of the studies completed by Ray and Rowlett, may be due to 1) the individual perception of method, 2) the dissimilarity of subjects, and 3) the possible non-equivalence of learning tasks. The present study is a refinement of Rowlett's (25) research.

Definition of Terms

Direct-Detailed Instruction: Method A. Subjects are provided with nine small models illustrating the three major types of surfaces encountered in orthographic projection. In addition, subjects are provided with a workbook of problems which includes 1) one, two, and three view orthographic drawings of the first model; 2) six view orthographic drawings of eight models (lines are omitted in six of these and are added by the subject); 3) four orthographic drawings involving missing lines; and 4) eleven problems involving decisions relative to view relationships, methods of revolving an object, and the selection of a correct "third view" from among several alternatives.

The taped instruction provides a step by step procedure for superimposing each of the models over the various views of the appropriate drawing. In addition, the subjects are instructed in a detailed manner in regard to revolving the object to provide the six possible views of an orthographic drawing. The three types of surfaces considered are treated in a direct and specific manner with an emphasis on correct and positive identification of the surfaces and with a frequent restatement of the principles relating to the surfaces. Types of lines and projection techniques are dealt with in a similar manner.

Subjects solve or make decisions in regard to twenty-one problems with the direct assistance of the experimenter. Taped instruction relating to the correct solution of problems is explicit and detailed and includes the rationale and principles involved in arriving at a given solution. Reinforcement is provided at the conclusion of each problem by the statement, "You have now completed problem____."

Directed Discovery Instruction: Method B. Subjects are provided with the identical models and workbooks used in Method A. Except for a brief introduction, subjects are left to their own methods of developing an understanding of the technique of revolving an object to provide the six possible views of an orthographic drawing. They are, however, provided with leading questions which are intended to structure their personal approaches to a predetermined system. The three types of surfaces which are studied are defined, but the subjects are again placed on their own, along with questions from the experimenter, to identify the surfaces under consideration. Types of lines and projection principles are dealt with by employing leading questions.

Subjects solve or make decisions in regard to twenty-one problems without direct assistance from the experimenter. Taped instruction relating to the solution of a problem is limited to questions which should direct the subjects' attention to the critical elements of the problem under consideration. Reinforcement is not utilized at the conclusion of each problem; instead, a question related to the problem is posed. Closure must be a product of the subjects' individual efforts.

Orthographic Projection Principles and Skills. Orthographic projection is a graphic method by means of which the precise shape of an object may be represented in one or more views on a flat plane. Each view has a specific location with reference to the other views. Line values representing visible and invisible elements are employed to clarify shape descriptions.

Problem Solving. A learning task involving problem solving opportunities is such that the problem under consideration is incomplete and may be solved only by the application, either implicitly or explicitly, of the principles of orthographic projection. These principles may be related to the problem by the experimenter, and the problem solved by the subjects with the direct assistance of the experimenter, or the subjects may be guided by leading questions to arrive at their own solutions.

Ability Levels. Three ability levels are considered in this study: high, average, and low. The high ability group tests at or above 45 on the *Revised Minnesota Paper Form Board Test*, the average group between 38 and 44, and the below average group at or below 37. The method of arriving at these cutting points is explained on page 13.

Initial Learning. Initial learning is defined as the extent to which subjects are able to apply the principles and skills of orthographic projection to the solution of multi-view problems that are similar, but not identical to, those used during the instructional period and their capacity to respond to questions in regard to surface and line identification and to view relationships. A multiple-choice test is used to determine the amount of initial learning as measured immediately after treatment.

Retention. Retention is defined as the degree to which subjects are able to apply the principles and skills of orthographic projection to the solution of multi-view problems that are similar, but not identical, to those used during the instructional period and their capacity to respond to questions in regard to surface and line identification and to view relationships as measured by a multiple-choice objective test administered one and six weeks after treatment.

Transfer. Transfer occurs when the subject is able to generalize previous learning and apply it to a new problem situation and/or when common elements exist in both new and old problems and this commonality is recognized by the subject. The amount of transfer is measured by a multiple-choice objective test administered one and six weeks after treatment utilizing problems that test for diversified application of general projection principles.

Statement of Hypotheses

Directional two-sided t-tests will be employed in contrast to the traditional use of the null hypothesis with its non-directional alternative. While an explicit statement of the directional alternatives to each of the null hypotheses (H_{1B} - H_{5B}) is implied, the alternatives will be stated for illustrative purposes only in regard to H_1.

1. H_{1A}: The subjects taught by Method "A" are superior in terms of initial learning.

   H_{1B}: There is no difference between the subjects taught by Method "A" and Method "B".

   H_{1C}: The subjects taught by Method "B" are superior in terms of initial learning.

2. H_{2B}: There is no difference between the subjects taught by Method "A" and Method "B" in terms of the retention and application of the principles of orthographic projection to the solution of problems of the same general type used in the instruction period as measured one week after treatment.

3. H_{3B}: There is no difference between the subjects taught by Method "A" and Method "B" in terms of transferring projection principles and skills to the solution of a wide range of problems as measured one week after treatment.

4. H_{4B}: There is no difference between the subjects taught by Method "A" and Method "B" in terms of the retention and application of the principles of orthographic projection to the solution of problems of the same general type used in the instruction period as measured six weeks after treatment.

5. H_{5B}: There is no difference between the subjects taught by Method "A" and Method "B" in terms of transferring projection principles and skills to the solution of a wide range of problems as measured six weeks after treatment.

The above hypotheses are pertinent to the total subjects in the two treatment groups. It seems desirable, in addition, to contrast the two treatments in terms of specific ability levels. Much has been written in educational literature suggesting that highly detailed instruction coupled with frequent drills is the most effective instructional method for students of low ability. On the other hand, current educational writing points up the acute need for developing more efficient methods of instructing students of high ability. It is often implied, if not explicitly stated, that the high-ability students are most productive when provided with a minimum of guidance and allowed to "think for themselves"; whereas, their counterparts at the opposite end of the ability continuum require detailed guidance if instruction is to be effective. This suggests that the directed discovery method may be superior for subjects of high ability and that the direct-detailed method may be the more effective instructional technique for subjects of low ability. Directional two-sided t-tests will be employed to compare each ability level by treatment in regard to initial learning, retention one and six weeks, and transfer one and six weeks. If interaction is found to be present, it will be possible to identify both the ability levels and treatments responsible.

THE RESEARCH EXPERIMENT

Experimental Research Design

A treatments x levels design is employed in this experimental study. Direct-detailed and directed discovery instructional methods and a single control comprise the three treatments. High, average, and low ability groups constitute the three levels. The independent variables are 1) instructional methods and 2) ability levels. The dependent variables are 1) initial learning as measured by an objective test administered immediately after treatment, 2) retention as measured one and six weeks after treatment, and 3) transfer as measured one and six weeks after treatment. The controlled variables consist of 1) length of instruction, 2) three-dimensional aids, 3) workbook of problems, 4) tests and testing conditions, and 5) content and instructional methods. It will be observed that "instructional methods" has been included as both an independent and controlled variable. The methods are controlled in the sense that all instruction is taped. In addition, for each of the two methods under consideration, an equal amount of instructional time is allocated for every principle, fact, or problem included in the instruction.

Population and Sampling

The subjects used in this experiment were randomly selected from among the women at Eastern Kentucky State College who had completed the first semester of the freshman year and who were enrolled in a required social science course. Male students were excluded because of the probability that a large number of them would be familiar with the learning task on the basis of high school and/or college experience.

The Revised Minnesota Paper Form Board Test was administered in February, 1961, to all students who were enrolled in Social Science 101.

Table 1 shows the distribution of available female subjects by levels.

TABLE 1

AVAILABLE SUBJECTS BY LEVEL AND THE CUT-OFF POINTS BY SCORES ON THE MINNESOTA PAPER FORM BOARD TEST

Level	--	Subjects
High 45 to 59		115
Average 38 to 44		108
Low 8 to 37		114
Total		N = 337

A sampling procedure outlined by Walker and Lev (34, 173-174) was employed in assigning the subjects to ability levels. The procedure consists of dividing the population into strata and then drawing random samples from each stratum. Walker and Lev state that this procedure is efficient "only if the strata or sub-populations can be selected in such a way that the variance of each stratum is smaller than the variance of the entire unstratified populations."

The sample size used in this study was determined by a system described in Walker and Lev (34). Four factors influenced the sample size: 1) the level of risk of committing an alpha error, 2) the level of risk of commiting a beta error, 3) the difference in the mean performance of the Treatments A and B groups on the criterion tests judged to be significant to the experimenter, and 4) an estimate of the variance based on previous research (25). The risk of committing an alpha error was set at .05, of committing a beta error at .10, and the difference in means at five points. With these decisions concerning alpha, beta, and delta and with an estimate of the variance, it was concluded that the two instructional groups should each be comprised of seventy-two subjects. The possibility should be pointed out that the data may warrant an acceptance of H_{1A} when in fact H_{1C} obtains. The probability of committing an error of this type (gamma) is always less than one-half the probability of committing an alpha error.

In an experiment of thes type the researcher is always faced with the probability that some subjects will be absent from their designated instructional and testing sessions. In anticipation of this, nine additional subjects, three from each ability level, were assigned to Treatments A and B, and three additional subjects to Treatment C, the control group. These were designated as replacements although this fact was unknown to the subjects involved. Although this precaution was taken, illness and withdrawals from the institution necessitated reducing the total Treatments A and B groups to sixty-three each, and the treatment C group to twenty-one. It was necessary to randomly eliminate several subjects in a manner to keep the Treatments A and B groups x ability levels at an equal size and the treatment C group proportionately equivalent. Table 2 shows the adjusted assignment of subjects to treatments and levels.

TABLE 2

ASSIGNMENT OF SUBJECTS TO TREATMENTS AND LEVELS

Level	Treatment A	Treatment B	Treatment C	Total
High 45 to 59	21	21	7	49
Average 38 to 44	21	21	7	49
Low 8 to 37	21	21	7	49
Total	63	63	21	N = 147

Table 3 shows the means and standard deviations of Minnesota Paper Form Board Test scores by cell, treatment, and level. An examination of Table 3 indicates that the sampling procedure is in accord with the criterion set forth by Walter and Lev.

TABLE 3

MEANS AND STANDARD DEVIATIONS OF MINNESOTA PAPER FORM BOARD TEST SCORES AND NUMBER OF SUBJECTS BY CELL, TREATMENT, AND LEVEL

Level	Treatment A	Treatment B	Treatment C	Total
High 45 to 59	$\bar{X} = 50.00$ $s = 3.73$ $n = 21$	$\bar{X} = 50.14$ $s = 4.14$ $n = 21$	$\bar{X} = 50.42$ $s = 4.28$ $n = 7$	$\bar{X} = 50.14$ $s = 3.86$ $n = 49$
Average 38 to 44	$\bar{X} = 41.28$ $s = 2.15$ $n = 21$	$\bar{X} = 41.24$ $s = 2.17$ $n = 21$	$\bar{X} = 41.71$ $s = 1.60$ $n = 7$	$\bar{X} = 41.32$ $s = 2.05$ $n = 49$
Low 8 to 37	$\bar{X} = 30.04$ $s = 5.41$ $n = 21$	$\bar{X} = 31.85$ $s = 5.22$ $n = 21$	$\bar{X} = 32.42$ $s = 3.96$ $n = 7$	$\bar{X} = 31.16$ $s = 5.03$ $n = 49$
Total	$\bar{X} = 40.44$ $s = 9.07$ $n = 63$	$\bar{X} = 41.08$ $s = 8.51$ $n = 63$	$\bar{X} = 41.57$ $s = 8.28$ $n = 21$	$\bar{X} = 40.88$ $s = 8.67$ $n = 147$

The means and variances of the Minnesota Paper Form Board Test scores of subjects assigned to Treatments A, B, and C do not differ significantly. An analysis of variance produced an insignificant F, thus permitting an acceptance of the hypothesis $\mu_A = \mu_B = \mu_C = \mu$. Furthermore, the means and variances of subjects within each ability level do not differ significantly. See Appendix E for the complete analysis.

A chi-square of 10.588 with $n = 14 - 3$ degrees of freedom indicates that the distribution of scores on the Minnesota Paper Form Board Test approaches normality. A chi-square value of 19.675 is necessary to reject the hypothesis of normality at the .05 level. The procedure used for testing this hypothesis may be found in Edwards (5, 384-387).

Table 4 shows the means and standard deviations of the chronological ages of subjects by cell, treatment and level.

TABLE 4

MEANS AND STANDARD DEVIATIONS OF CHRONOLOGICAL AGES AND NUMBER OF SUBJECTS BY CELL, TREATMENT, AND LEVEL

Level	Treatment A	Treatment B	Treatment C
High 45 to 59	$\bar{X}$ = 19.08 s = 2.269 n = 21	$\bar{X}$ = 18.62 s = 1.463 n = 21	$\bar{X}$ = 19.04 s = .923 n = 7
Average 38 to 44	$\bar{X}$ = 18.91 s = 1.320 n = 21	$\bar{X}$ = 18.94 s = 1.476 n = 21	$\bar{X}$ = 19.20 s = .934 n = 7
Low 8 to 37	$\bar{X}$ = 18.89 s = 1.785 n = 21	$\bar{X}$ = 18.90 s = 1.487 n = 21	$\bar{X}$ = 18.75 s = .565 n = 7
Total	$\bar{X}$ = 18.96 s = 1.805 n = 63	$\bar{X}$ = 18.83 s = 1.458 n = 63	$\bar{X}$ = 19.00 s = .792 n = 21

While it is necessary to reject the hypothesis $\sigma^2_A = \sigma^2_B = \sigma^2_C = \sigma^2$, due to the small variance in the control group, the hypothesis $\mu_A = \mu_B = \mu_C$ is accepted on the basis of a test explained in Walker and Lev (34, 157). The data in regard to chronological age are presented as a matter of general information and are not involved in the equating of groups or in hypothesis testing.

The Learning Task

Orthographic projection principles and skills were selected as the learning task for this experimental study. As previously defined, orthographic projection is a graphic method by means of which the precise shape of an object may be represented in one or more views on a flat plane. Subjects were taught 1) the names and locations of the six possible views used in this system of projection; 2) the methods of revolving an object to produce these views; 3) the projection principles that enable one to transfer shapes and measurements from one view to another; 4) the representation of normal, inclined, and curved surfaces; and 5) line symbols representing projection lines and visible and invisible features. The taped instruction was related to a workbook of problems which the students solved as the instruction was presented. A copy of the workbook is included in Appendix B.

Differential Treatments

The subjects in this experiment were randomly assigned by ability levels to Treatments A, B, and C. The subjects in Treatment C, the control group, received no instruction. They took the written examinations to give the experimenter some indication of an uninstructed group's capacity to respond to the questions.

The subjects assigned to Treatments A and B received forty-three minutes of instruction. Both groups received identical instruction for the first eight minutes. It consisted of 1) a statement of the purpose of the research study; 2) an explanation of the practical applications of orthographic projection; 3) a brief introduction to the names and locations of the front, top, and right side views; 4) an explanation of the methods of revolving an object to obtain the front, top, and right side views; 5) a short introduction to projection principles and techniques; and 6) a brief treatment of the use of visible and projection lines. The remaining thirty-five minutes of instructional time was devoted to differential treatments.

The direct-detailed group received continuous instruction throughout the thirty-five minutes with the exception of normal pauses at the end of sentences and when it was necessary for subjects to manipulate three-dimensional objects or turn the pages of the workbook. This method is analogous to that employed by the instructor who works through a number of problems on the blackboard for his students, gives careful and detailed instruction, but maintains a personal responsibility for the method employed and the solution of the posed problem.

The subjects taught by the directed discovery method were presented with the identical problems but were asked leading questions that suggested both methods of attack and critical points in the solution of a given problem. This instruction incorporated a number of pauses. Subjects were expected to use these intervals to think through the problems on their own, using whatever hints were provided by the instructor. It should be pointed out, however, that for a given problem, each group was allowed an identical amount of time. See Appendix A for the typescript of the taped instruction used in Treatments A and B.

Instructional Procedures

Table 5 illustrates the composition of each instructional and testing group. See Appendix F for the teaching and testing schedules.

TABLE 5

COMPOSITION OF EACH INSTRUCTIONAL GROUP

Level	Subjects
High 45 to 59	7
Average 38 to 44	7
Low 8 to 37	7
Total	21

Written Tests

The examinations administered during the course of the experiment involved multiple-choice items. Table 6 illustrates the character of the tests employed in this study. All subjects were able to complete each of the criterion tests with time to spare.

TABLE 6

CRITERION TESTS

Type of Test	Items	Possible Points	Time
Initial Learning	65	65	50 minutes
Retention One Week	65	65	50 minutes
Transfer One Week	44	44	50 minutes
Retention Six Weeks	65	65	50 minutes
Transfer Six Weeks	44	44	50 minutes

The test of initial learning was composed of three sub-tests. Table 7 illustrates the composition of this and the retention tests.

TABLE 7

COMPOSITION OF INITIAL LEARNING AND RETENTION TESTS

Test	No. Items	No. Points	Description
Sub-test 1	13	13	Surface and line identification; view placement
Sub-test 2	28	28	View selection with pictorial omitted
Sub-test 3	24	24	View selection with aid of pictorial
Total Test	65	65	

The first section of the test, sub-test 1, presented the subject with objective items in regard to 1) identification of surfaces and lines and 2) view placement.

Sub-test 2 attempted to measure the subject's understanding of view relationships and representation in orthographic projection. The subject was presented with a completed two-view orthographic drawing and was required to select a third view, such as the left side, from among five possible views.

Sub-test 3 presented the subject with a pictorial drawing of an object and five possible orthographic views of a surface of that object, such as bottom views. The subject was required to choose, from among these alternatives, the orthographic view that seemed correct for a specified pictorial surface. One surface of the pictorial drawing was identified in order that the subject could assume the proper orientation in viewing the object. The subject was required to revolve mentally the object in order to bring the correct surface into view.

The initial learning test was re-administered to measure retention one and six weeks after treatment. It was deemed unnecessary to disguise the test items due to the large number employed and their complexity. In addition, it should be pointed out that subjects were not permitted to examine any of the corrected tests during the course of the experiment. Appendix C contains a copy of the instrument employed to measure initial learning and retention.

The transfer one and six weeks tests were identical. An instrument was designed employing multiple-choice items to measure the degree to which subjects were able to generalize and apply previous learning in solving problems of a different nature from those used in the instructional period.

Sub-test 4 presented the subject with a two-view orthographic drawing and five possible pictorial drawings of the object described in the orthographic drawing. Subjects were directed to choose the pictorial drawing that corresponded with the orthographic drawing.

Sub-test 5 consisted of primary auxiliary view problems. Each test item consisted of a three-view orthographic drawing with five possible partial auxiliary views projected from the inclined surface of the object. The subject was required to make a selection from among these views.

Sub-test 6 was composed of orthographic projection problems of a two-dimensional type in contrast to the three-dimensional objects to which the instruction was related.

Sub-test 7 was composed of problems based on the European system of orthographic projection. This system involves locating views in a manner different from the American system. A brief instruction sheet was included in the test to explain the differences between the two systems. Table 8 illustrates the composition of the transfer test. Appendix D contains a copy of the instrument employed to measure transfer.

TABLE 8

COMPOSITION OF TRANSFER TESTS

Test	No. of Items	No. Points	Description
Sub-test 4	8	8	Pictorial selection from orthographic drawing
Sub-test 5	4	4	Primary auxiliary views
Sub-test 6	8	8	Two-dimensional orthographic views
Sub-test 7	24	24	European system of orthographic projection.
Total Test	44	44	

The reliability coefficients of the five criterion tests are included in Table 9. The reliability coefficients were computed by split-halves, corrected by the Spearman-Brown Prophecy Formula as explained in Edwards (5, 176-177).

TABLE 9

RELIABILITY COEFFICIENTS OF CRITERION TESTS

Test	N = 126
Initial Learning	.92
Transfer One Week	.91
Retention One Week	.86
Retention Six Weeks	.96
Transfer Six Weeks	.87

Statistical Treatment of Data

The t-test will be employed in testing the directional two-sided hypotheses. There seems to be a distinct logical advantage for using the directional two-sided test in contrast to the traditional non-directional two-tailed test. An explicit statement of the hypotheses to be tested in this study, if a non-directional two-tailed test were used, would take the following form: H: $\mu_B - \mu_A = 0$ and the alternative, $\bar{H}$ $\mu_B - \mu_A \neq 0$. As Kaiser has pointed out, (15) the researcher is faced with an extrastatistical problem of identifying the direction of the obtained differences if the data warrant an acceptance of $\bar{H}$. An explicit acceptance of $\bar{H}$ would enable the researcher to state logically nothing more than the fact that the means are different. In order to avoid this logical pitfall, the hypotheses tested in this study are stated in the following manner: H_{1A}: $\mu_B - \mu_A < 0$; H_{1B}: $\mu_B - \mu_A = 0$; and H_{1C}: $\mu_B - \mu_A > 0$.

HYPOTHESIS TESTING AND RESULTS

The Control Group

The control group was included in the research design for two distinct purposes. First, it seemed pertinent to gain some indication of an uninstructed group's capacity to respond to the written examinations. Second, the researcher wished to investigate the possibility that the subjects in this group would learn as they took the various tests. An examination of the learning curves (Figures 1 and 2, pp.25-26) indicates that the high ability level of the control group scored progressively higher at each successive testing interval.

The subjects taught by Treatments A and B proved superior to those in the control group on each of the five criterion tests. This evidence indicates that the forty-three minutes of taped instruction, irrespective of method of organization, was productive of a quality of learning that persisted and was usable six weeks after instruction. Although the research design made no provisions for a formal comparison of Treatments A and B with Treatment C, this contrast was made using a test explained in Walker and Lev (34, 157). See Appendix H for these comparisons.

Learning Scores

Tables 10-14 present the means and standard deviations of the learning scores by treatment and level. Figure 1, p.25, presents the learning curves of the three treatment groups in terms of initial learning and retention one and six weeks. Figure 2, p.26, illustrates the learning curves of Treatments A, B, and C, on the transfer one and six weeks tests. All three ability levels receiving Treatment B show an increase in performance on the transfer six weeks test; of the Treatment A levels, only the low ability shows a comparable gain.

Hypothesis Testing

Tables 10-14 provide the framework for testing hypotheses 1-5. $N_A + N_B - 2$ degrees of freedom are available for each of the t-tests. It has been pointed out previously that directional two-sided t-tests are employed. The risks involved in committing the following errors are: 1) alpha = .05, 2) beta = .10, and 3) gamma = less than one-half the probability of committing an alpha error.

FIGURE 1 - RETENTION CURVES

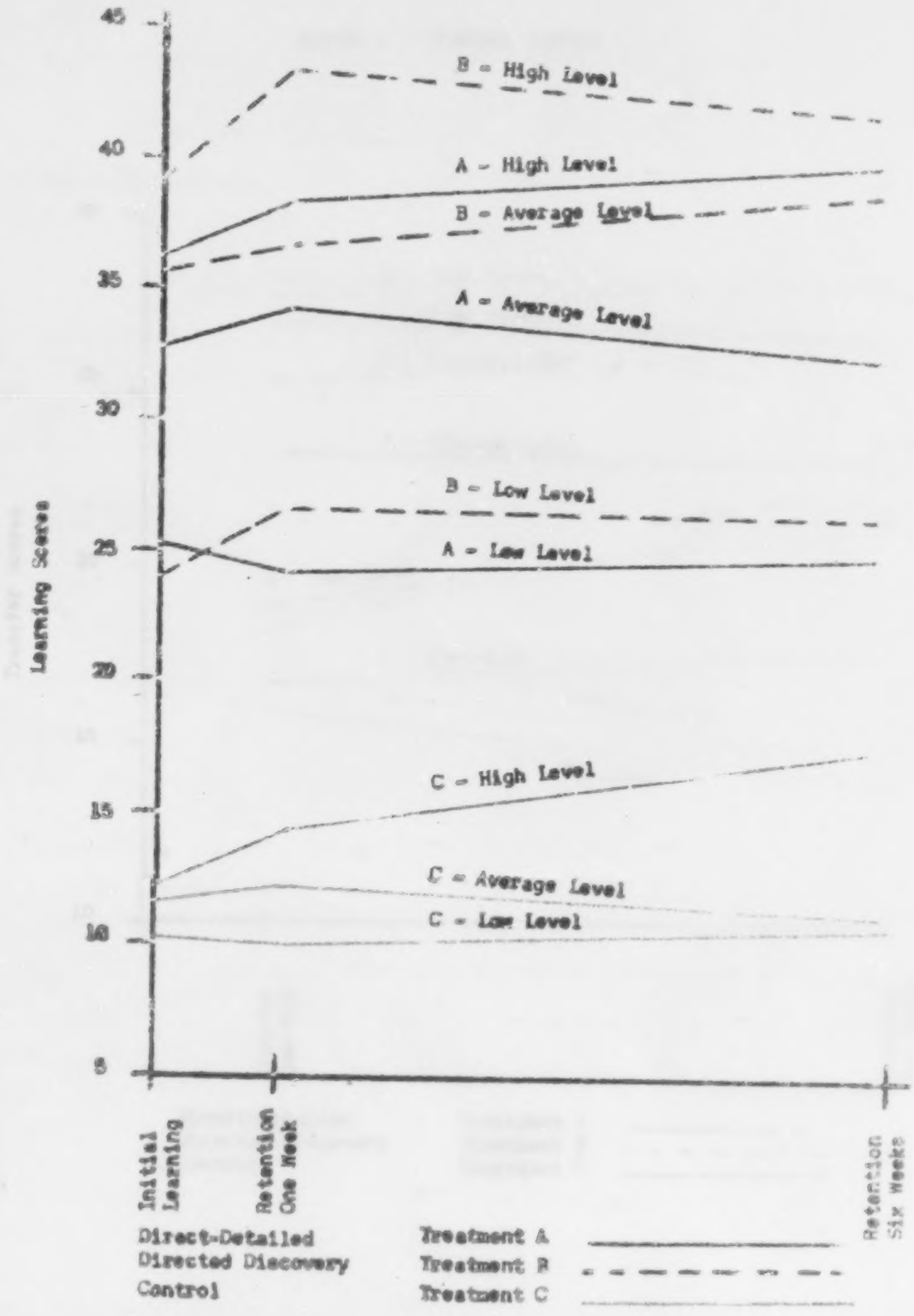
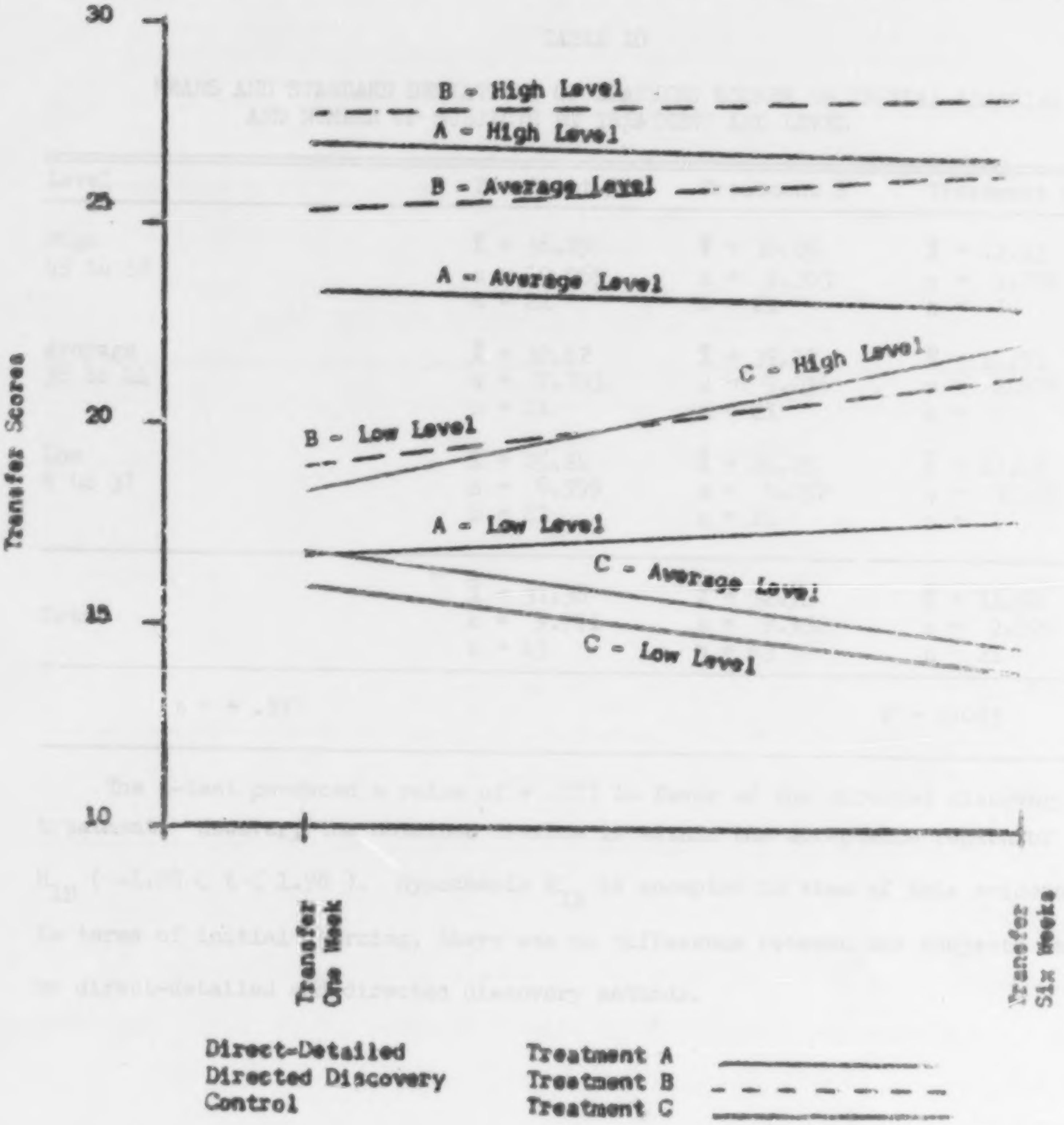


FIGURE 2 - TRANSFER CURVES



Test of Hypothesis H_1

HYPOTHESIS H_1

H_{1A} : The subjects taught by Method "A" are superior in terms of initial learning.

H_{1B} : There is no difference between the subjects taught by Method "A" and Method "B" in terms of initial learning.

H_{1C} : The subjects taught by Method "B" are superior in terms of initial learning.

TABLE 10

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES ON INITIAL LEARNING TESTS AND NUMBER OF SUBJECTS BY TREATMENT AND LEVEL

Level	Treatment A	Treatment B	Treatment C
High 45 to 59	$\bar{X}$ = 36.29 s = 10.069 n = 21	$\bar{X}$ = 39.05 s = 9.303 n = 21	$\bar{X}$ = 12.43 s = 2.758 n = 7
Average 38 to 44	$\bar{X}$ = 32.62 s = 7.703 n = 21	$\bar{X}$ = 35.72 s = 5.036 n = 21	$\bar{X}$ = 11.71 s = 2.688 n = 7
Low 8 to 37	$\bar{X}$ = 25.24 s = 8.999 n = 21	$\bar{X}$ = 24.05 s = 8.052 n = 21	$\bar{X}$ = 10.43 s = 3.358 n = 7
Total	$\bar{X}$ = 31.38 s = 9.971 n = 63	$\bar{X}$ = 32.94 s = 9.952 n = 63	$\bar{X}$ = 11.52 s = 2.926 n = 21
t = + .877			F = 1.003

The t-test produced a value of + .877 in favor of the directed discovery treatment. However, the obtained t-value is within the acceptance region of H_{1B} ($-1.98 < t < 1.98$). Hypothesis H_{1B} is accepted in view of this evidence. In terms of initial learning, there was no difference between the subjects taught by direct-detailed and directed discovery methods.

Test of Hypothesis H_2

HYPOTHESIS H_2

H_{2A}: The subjects taught by Method "A" are superior in terms of the retention and application of the principles of orthographic projection to the solution of problems of the same general type used in the instruction period as measured one week after treatment.

H_{2B}: There is no difference between the subjects taught by Method "A" and Method "B" in terms of the retention and application of the principles of orthographic projection to the solution of problems of the same general type used in the instruction period as measured one week after treatment.

H_{2C}: The subjects taught by Method "B" are superior in terms of the retention and application of the principles of orthographic projection to the solution of problems of the same general type used in the instruction period as measured one week after treatment.

TABLE 11

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES ON RETENTION ONE WEEK TEST AND NUMBER OF SUBJECTS BY TREATMENT AND LEVEL

Level	Treatment A	Treatment B	Treatment C
High 45 to 59	$\bar{X}$ = 38.43 s = 10.749 n = 21	$\bar{X}$ = 43.38 s = 9.635 n = 21	$\bar{X}$ = 14.43 s = 4.577 n = 7
Average 38 to 44	$\bar{X}$ = 34.29 s = 9.928 n = 21	$\bar{X}$ = 36.71 s = 10.583 n = 21	$\bar{X}$ = 12.43 s = 3.154 n = 7
Low 8 to 37	$\bar{X}$ = 24.19 s = 8.483 n = 21	$\bar{X}$ = 26.86 s = 6.110 n = 21	$\bar{X}$ = 10.14 s = 2.966 n = 7
Total	$\bar{X}$ = 32.30 s = 11.349 n = 63	$\bar{X}$ = 35.65 s = 11.180 n = 63	$\bar{X}$ = 12.33 s = 3.889 n = 21

$t = + 1.67$ $\qquad$ $F = 1.030$

The t-test produced a value of + 1.67 in favor of the directed discovery treatment. However, the obtained t-value is within the acceptance region of H_{2B} ($-1.98 < t < 1.98$). Hypothesis H_{2B} is accepted in view of this evidence. In terms of retention, there was no difference between the subjects taught by direct-detailed and directed discovery methods when contrasted one week after treatment.

Test of Hypothesis H_3

HYPOTHESIS H_3

H_{3A}: The subjects taught by Method "A" are superior in terms of transferring projection principles and skills to the solution of a wide range of problems as measured one week after treatment.

H_{3B}: There is no difference between the subjects taught by Method "A" and Method "B" in terms of transferring projection principles and skills to the solution of a wide range of problems as measured one week after treatment.

H_{3C}: The subjects taught by Method "B" are superior in terms of transferring projection principles and skills to the solution of a wide range of problems as measured one week after treatment.

TABLE 12

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES ON TRANSFER
ONE WEEK TEST AND NUMBER OF SUBJECTS BY TREATMENT AND LEVEL

Level	Treatment A	Treatment B	Treatment C
High 45 to 59	$\bar{X} = 27.00$ $s = 7.315$ $n = 21$	$\bar{X} = 27.76$ $s = 7.641$ $n = 21$	$\bar{X} = 18.28$ $s = 5.047$ $n = 7$
Average 38 to 44	$\bar{X} = 23.33$ $s = 5.975$ $n = 21$	$\bar{X} = 25.43$ $s = 6.185$ $n = 21$	$\bar{X} = 16.86$ $s = 2.268$ $n = 7$
Low 8 to 37	$\bar{X} = 16.71$ $s = 6.615$ $n = 21$	$\bar{X} = 19.00$ $s = 5.568$ $n = 21$	$\bar{X} = 16.00$ $s = 2.000$ $n = 7$
Total	$\bar{X} = 22.35$ $s = 7.828$ $n = 63$	$\bar{X} = 24.06$ $s = 7.424$ $n = 63$	$\bar{X} = 17.05$ $s = 3.528$ $n = 21$

$t = + 1.26$ $F = 1.112$

The t-test produced a value of + 1.26 in favor of the directed discovery treatment. However, the obtained t-value is within the acceptance region of H_{3B} ($-1.98 < t < 1.98$). Hypothesis H_{3B} is accepted in view of this evidence. There was no difference between the subjects receiving direct-detailed and directed discovery instruction in terms of transferring projection principles and skills as measured one week after treatment.

Test of Hypothesis H_4

HYPOTHESIS H_4

H_{4A}: The subjects taught by Method "A" are superior in terms of the retention and application of the principles of orthographic projection to the solution of problems of the same general type used in the instruction period as measured six weeks after treatment.

H_{4B}: There is no difference between the subjects taught by Method "A" and Method "B" in terms of the retention and application of the principles of orthographic projection to the solution of problems of the same general type used in the instruction period as measured six weeks after treatment.

H_{4C}: The subjects taught by Method "B" are superior in terms of the retention and application of the principles of orthographic projection to the solution of problems of the same general type used in the instruction period as measured six weeks after treatment.

TABLE 13

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES ON RETENTION SIX WEEKS TEST AND NUMBER OF SUBJECTS BY TREATMENT AND LEVEL

Level	Treatment A	Treatment B	Treatment C
High 45 to 59	$\bar{X}$ = 39.76 s = 11.908 n = 21	$\bar{X}$ = 41.52 s = 11.347 n = 21	$\bar{X}$ = 17.86 s = 7.426 n = 7
Average 38 to 44	$\bar{X}$ = 32.33 s = 10.752 n = 21	$\bar{X}$ = 38.95 s = 9.222 n = 21	$\bar{X}$ = 11.43 s = 4.353 n = 7
Low 8 to 37	$\bar{X}$ = 24.81 s = 8.992 n = 21	$\bar{X}$ = 26.48 s = 7.653 n = 21	$\bar{X}$ = 11.00 s = 3.558 n = 7
Total	$\bar{X}$ = 32.30 s = 12.124 n = 63	$\bar{X}$ = 35.65 s = 11.476 n = 63	$\bar{X}$ = 13.43 s = 6.029 n = 21

$t = + 1.59$ $F = 1.116$

The t-test produced a value of + 1.59 in favor of the directed discovery treatment. However, the obtained t value is within the acceptance region of H_{4B} ($-1.98 < t < 1.98$). Hypothesis H_{4B} is accepted in view of this evidence. In terms of retention, there was no difference between the subjects taught by direct-detailed and directed discovery methods when contrasted six weeks after treatment.

Test of Hypothesis H_5

HYPOTHESIS H_5

H_{5A}: The subjects taught by Method "A" are superior in terms of transferring projection principles and skills to the solution of a wide range of problems as measured six weeks after treatment.

H_{5B}: There is no difference between the subjects taught by Method "A" and Method "B" in terms of transferring projection principles and skills to the solution of a wide range of problems as measured six weeks after treatment.

H_{5C}: The subjects taught be Method "B" are superior in terms of transferring projection principles and skills to the solution of a wide range of problems as measured six weeks after treatment.

TABLE 14

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES ON TRANSFER SIX WEEKS TEST AND NUMBER OF SUBJECTS BY TREATMENT AND LEVEL

Level	Treatment A	Treatment B	Treatment C
High 45 to 59	$\bar{X}$ = 26.76 s = 7.661 n = 21	$\bar{X}$ = 28.29 s = 6.482 n = 21	$\bar{X}$ = 22.18 s = 4.181 n = 7
Average 38 to 44	$\bar{X}$ = 23.05 s = 6.054 n = 21	$\bar{X}$ = 26.48 s = 5.862 n = 21	$\bar{X}$ = 14.57 s = 3.409 n = 7
Low 8 to 37	$\bar{X}$ = 17.71 s = 5.574 n = 21	$\bar{X}$ = 21.43 s = 5.963 n = 21	$\bar{X}$ = 14.00 s = 5.099 n = 7
Total	$\bar{X}$ = 22.51 s = 7.402 n = 63	$\bar{X}$ = 25.40 s = 6.683 n = 63	$\bar{X}$ = 16.91 s = 5.567 n = 21
	t = + 2.30		F = 1.226

The t-test produced a value of + 2.30 in favor of the directed discovery treatment. The obtained t-value is within the critical region of H_{5C} ($1.98 < t < \infty$). Hypothesis H_{5C} is accepted in view of this evidence. The subjects taught by the directed discovery method were superior in transferring projection principles and skills as measured six weeks after treatment.

General Discussion

The t-tests on the preceding pages produced values that favored the directed discovery method, but in only one instance, H_5, was a value statistically significant. In a previous study Rowlett (25) found that the directed discovery method was superior to a statistically significant degree in regard to H_2, H_3, H_4, and H_5. In this study the mean of the differences of the means of six matched groups provided a statistic, $\bar{D}$, which was employed in testing the hypotheses.

A directional two-sided t-test with $N_A + N_B - 2$ degrees of freedom was employed in the present study. The direction of the differences between Treatments A and B is consistent for both studies. The dissimilarities in the findings of the two studies may be attributed to a number of factors. Among these are differences in 1) populations, 2) sample sizes, 3) length of instructional time, 4) content and problems, 5) criterion tests, 6) intervals between initial learning and first retention and transfer tests, and 7) statistical treatment of data.

A posteriori reasoning suggests that an alternative statistical treatment would have enabled the researcher to state that the directed discovery method is superior in regard to H_2, H_4, and H_5. As a matter of general interest, $H_1 - H_5$ were tested using a matched means technique described in Edwards (5). Inasmuch as the research design did not provide for this test, but in fact specified another, the researcher is not privileged to select the test that produces the greatest number of significant differences after the data are in.

Interaction

Tables 15-29 present comparisons of Treatment A and Treatment B by ability levels on each of the criterion tests. The t-values and F-values are included in each of the tables. It will be observed that only one F-value is significant at the .10 level. However, this value is not significant at the .02 level. The F-tests were used in testing H: $\sigma^2_{Ai} = \sigma^2_{Bi}$ against $\bar{H}$: $\sigma^2_{Ai} \neq \sigma^2_{Bi}$.

Thirteen of the fifteen t-tests that were made comparing each ability level by treatment on the five criterion tests present evidence to support the hypothesis $\mu_{Ai} = \mu_{Bi}$. The obtained t-values are in the acceptance region of ($-2.02 < t < 2.02$). Two of the fifteen t-tests produced statistically significant t-values in regard to the low and average ability groups receiving directed discovery instruction. The average ability group was superior in terms of the retention six weeks test, and the low ability group was superior on the transfer six weeks test. In summary, of the fifteen t-tests, fourteen of the obtained values favored the directed discovery groups although in only two cases were the differences statistically significant. A comparison of the low ability groups on the initial learning test produced a t-value of .45 in the direction of the Treatment A group.

On the basis of the above analysis and in consideration of the fact that tests of $H_1 - H_5$ produced t-values favoring the directed discovery method, it seems reasonable to conclude that the interaction phenomenon was not present. There is no evidence to suggest that a particular ability level or levels profited more, to a statistically significant degree, from Treatment A in comparison with an equivalent level or levels receiving Treatment B.

TABLE 15

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES OF HIGH ABILITY LEVEL SUBJECTS ON INITIAL LEARNING TEST BY TREATMENT

	Treatment A	Treatment B
	$\bar{X}$ = 36.29	$\bar{X}$ = 39.05
	s = 10.069	s = 9.303
	n = 21	n = 21
t = + .923		F = 1.171

TABLE 16

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES OF AVERAGE ABILITY LEVEL SUBJECTS ON INITIAL LEARNING TEST BY TREATMENT

	Treatment A	Treatment B
	$\bar{X}$ = 32.62	$\bar{X}$ = 35.72
	s = 7.703	s = 5.036
	n = 21	n = 21
t = + 1.54		* F = 2.339

* $F_{.95}$ = 2.00

$F_{.99}$ = 2.70

TABLE 17

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES OF LOW ABILITY LEVEL SUBJECTS ON INITIAL LEARNING TEST BY TREATMENT

	Treatment A	Treatment B
	$\bar{X}$ = 25.24	$\bar{X}$ = 24.05
	s = 8.999	s = 8.052
	n = 21	n = 21
t = -.452		F = 1.249

TABLE 18

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES OF HIGH ABILITY LEVEL SUBJECTS ON RETENTION ONE WEEK TEST BY TREATMENT

	Treatment A	Treatment B
	$\bar{X}$ = 38.43 s = 10.749 n = 21	$\bar{X}$ = 43.38 s = 9.635 n = 21
t = + 1.57		F = 1.244

TABLE 19

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES OF AVERAGE ABILITY LEVEL SUBJECTS ON RETENTION ONE WEEK TEST BY TREATMENT

	Treatment A	Treatment B
	$\bar{X}$ = 34.29 s = 9.928 n = 21	$\bar{X}$ = 36.71 s = 10.583 n = 21
t = + .767		F = 1.136

TABLE 20

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES OF LOW ABILITY LEVEL SUBJECTS ON RETENTION ONE WEEK TEST BY TREATMENT

	Treatment A	Treatment B
	$\bar{X}$ = 24.19 s = 8.483 n = 21	$\bar{X}$ = 26.86 s = 6.110 n = 21
t = + 1.17		F = 1.927

TABLE 21

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES OF HIGH ABILITY LEVEL SUBJECTS ON TRANSFER ONE WEEK TEST BY TREATMENT

	Treatment A	Treatment B
	$\bar{X}$ = 27.00 s = 7.315 n = 21	$\bar{X}$ = 27.76 s = 7.641 n = 21
t = + .330		F = 1.091

TABLE 22

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES OF AVERAGE ABILITY LEVEL SUBJECTS ON TRANSFER ONE WEEK TEST BY TREATMENT

	Treatment A	Treatment B
	$\bar{X}$ = 23.33 s = 5.975 n = 21	$\bar{X}$ = 25.43 s = 6.185 n = 21
t = + 1.12		F = 1.071

TABLE 23

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES OF LOW ABILITY LEVEL SUBJECTS ON TRANSFER ONE WEEK TEST BY TREATMENT

	Treatment A	Treatment B
	$\bar{X}$ = 16.71 s = 6.615 n = 21	$\bar{X}$ = 19.00 s = 5.568 n = 21
t = + 1.21		F = 1.411

TABLE 24

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES OF HIGH ABILITY LEVEL SUBJECTS ON RETENTION SIX WEEKS TEST BY TREATMENT

	Treatment A	Treatment B
	$\bar{X}$ = 39.76	$\bar{X}$ = 41.52
	s = 11.908	s = 11.347
	n = 21	n = 21
t = + .491		F = 1.101

TABLE 25

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES OF AVERAGE ABILITY LEVEL SUBJECTS ON RETENTION SIX WEEKS TEST BY TREATMENT

	Treatment A	Treatment B
	$\bar{X}$ = 32.33	$\bar{X}$ = 38.95
	s = 10.752	s = 9.222
	n = 21	n = 21
* t = + 2.14		F = 1.359

* $t_{.975}$ = 2.02

TABLE 26

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES OF LOW ABILITY LEVEL SUBJECTS ON RETENTION SIX WEEKS TEST BY TREATMENT

	Treatment A	Treatment B
	$\bar{X}$ = 24.81	$\bar{X}$ = 26.48
	s = 8.992	s = 7.653
	n = 21	n = 21
t = + .647		F = 1.380

TABLE 27

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES OF HIGH ABILITY LEVEL SUBJECTS ON TRANSFER SIX WEEKS TEST BY TREATMENT

Treatment A	Treatment B
$\bar{X}$ = 26.76	$\bar{X}$ = 28.29
s = 7.661	s = 6.482
n = 21	n = 21
t = + .696	F = 1.397

TABLE 28

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES OF AVERAGE ABILITY LEVEL SUBJECTS ON TRANSFER SIX WEEKS TEST BY TREATMENT

Treatment A	Treatment B
$\bar{X}$ = 23.05	$\bar{X}$ = 26.48
s = 6.054	s = 5.862
n = 21	n = 21
t = + 1.86	F = 1.065

TABLE 29

MEANS AND STANDARD DEVIATIONS OF LEARNING SCORES OF LOW ABILITY LEVEL SUBJECTS ON TRANSFER SIX WEEKS TEST BY TREATMENT

Treatment A	Treatment B
$\bar{X}$ = 17.71	$\bar{X}$ = 21.43
s = 5.574	s = 5.963
n = 21	n = 21
* t = + 2.08	F = 1.144

* $t_{.975}$ = 2.02

Intercorrelations

Appendix G contains the intercorrelations of the total test scores of the five criterion tests. Intercorrelations ranged from .74 to .86. All correlations were sufficiently high to reject the hypothesis $\rho = 0$ at the .0005 level.

Efficiency of Equating Instrument

In using the Revised Minnesota Paper Form Board Test to establish ability levels for this experiment the assumption was made that a positive relationship exists between performance on this test and the mastery of the learning task as reflected in tests of initial learning, retention, and transfer. That this assumption is tenable is evidenced by correlations ranging from .49 to .61 between scores on the equating instrument and the five criterion tests. On the basis of these relationships the hypothesis $\rho = 0$ may be rejected at the .0005 level. See Appendix G for a more detailed treatment of these relationships.

Performance Gains on Retention Tests

Tables 30-33 present data in regard to gains in performance of the Treatment A and Treatment B groups on retention one and six weeks tests in contrast to their levels of performance on the initial learning test. A statistical test described in Walker and Lev (34, 154) is employed to test for significant increases in performance.

TABLE 30

COMPARISON OF GAIN IN PERFORMANCE OF TREATMENT A GROUP ON INITIAL LEARNING AND RETENTION ONE WEEK TESTS

Initial Learning	Retention One Week
$\bar{X} = 31.38$ $s = 9.971$ $n = 63$	$\bar{X} = 32.30$ $s = 11.349$ $n = 63$

$D = .92$ $r = .95$ * $t = 2.01$

* $t_{.975} = 2.00$

On the basis of the above comparison one may conclude that the Treatment A group performed at a statistically significant higher level on the retention one week test in contrast to performance on the initial learning test.

TABLE 31

COMPARISON OF GAIN IN PERFORMANCE OF TREATMENT B GROUP ON INITIAL LEARNING AND RETENTION ONE WEEK TESTS

Initial Learning	Retention One Week
$\bar{X} = 32.94$ $s = 9.952$ $n = 63$	$\bar{X} = 35.65$ $s = 11.180$ $n = 63$

$D = 2.71$ $r = .89$ * $t = 4.22$

* $t_{.975} = 2.00$

The above comparison indicates that the gain in performance of the Treatment B group on the retention one week test is statistically significant.

TABLE 32

COMPARISON OF GAIN IN PERFORMANCE OF TREATMENT A GROUP ON INITIAL LEARNING AND RETENTION SIX WEEKS TESTS

Initial Learning	Retention Six Weeks
$\bar{X}$ = 31.38	$\bar{X}$ = 32.30
s = 9.971	s = 12.124
n = 63	n = 63

D = .92 r = .85 t = 1.14

On the basis of the above comparison one may conclude that the Treatment A group did not perform at a significantly higher level on the retention six weeks test in contrast to performance on the initial learning test.

TABLE 33

COMPARISON OF GAIN IN PERFORMANCE OF TREATMENT B GROUP ON INITIAL LEARNING AND RETENTION SIX WEEKS TESTS

Initial Learning	Retention Six Weeks
$\bar{X}$ = 32.94	$\bar{X}$ = 35.65
s = 9.971	s = 11.476
n = 63	n = 63

D = 2.71 r = .82 * t = 3.26

$t_{.975} = 2.00$

The above comparison indicates that the gain in performance of the Treatment B group on the retention six weeks test is statistically significant.

Performance Gains on Transfer Tests

Tables 34-35 present data in regard to gains in performance of the Treatment A and Treatment B groups on the transfer six weeks test in contrast to their levels of performance on the initial learning test. A statistical test described in Walker and Lev (34, 154) is employed to test for significant increases in performance.

TABLE 34

COMPARISON OF GAIN IN PERFORMANCE OF TREATMENT A GROUP ON TRANSFER ONE AND SIX WEEKS TESTS

Transfer One Week	Transfer Six Weeks
$\bar{X} = 22.35$ $s = 7.828$ $n = 63$	$\bar{X} = 22.51$ $s = 7.402$ $n = 63$

$D = .16$ $r = .88$ $t = .34$

A t-value of .34 indicates that the Treatment A group did not make a significant gain on the transfer six weeks test.

TABLE 35

COMPARISON OF GAIN IN PERFORMANCE OF TREATMENT B GROUP ON TRANSFER ONE AND SIX WEEKS TESTS

Transfer One Week	Transfer Six Weeks
$\bar{X} = 24.06$ $s = 7.424$ $n = 63$	$\bar{X} = 25.40$ $s = 6.683$ $n = 63$

$D = 1.34$ $r = .83$ * $t = 2.54$

$t_{.975} = 2.00$

One may conclude on the basis of the above comparison that the Treatment B group performed at a significantly higher level on the transfer six weeks test in contrast to performance on the transfer one week test.

SUMMARY AND CONCLUSIONS

The Problem

The purpose of this study has been to provide formal research evidence as to the effectiveness of two selected methods of organizing and presenting taped instruction as measured by 1) initial learning, 2) retention, and 3) transfer in a learning situation involving problem solving with meaningful materials. The experiment was designed, in addition, to test for interaction between methods and high, average, and low ability levels. A direct-detailed method of organization involving highly specific instruction was contrasted with a directed discovery method characterized by leading questions and "hints".

Experimental Research Design

A treatments x levels design was employed in this research study. Directed discovery and direct-detailed methods, and a single control comprised the three treatments. High, average, and low ability groups constituted the three levels. The independent variables were 1) instructional methods, and 2) ability levels. The dependent variables were 1) initial learning as measured by an objective test administered immediately after treatment, 2) retention as measured one and six weeks after treatment, and 3) transfer as measured one and six weeks after treatment. The controlled variables consisted of 1) length of instruction, 2) three-dimensional aids, 3) workbook of problems, 4) tests and testing conditions, and 5) content and instructional methods.

Population and Sampling

The subjects used in this experiment were randomly selected from among the women at Eastern Kentucky State College who had completed the first semester of the freshman year and who were enrolled in a required social science course. Male students were excluded because of the probability that a large number of them would be familiar with the learning task on the basis of high school and/or college experience. The Revised Minnesota Paper Form Board Test was administered in February, 1961, to all students who were enrolled in Social Science 101. The scores of the females were arranged in order of magnitude and then divided into three strata. Random samples were drawn from each stratum. Sixty-three subjects were assigned to Treatment A; an equal number to Treatment B; and twenty-one subjects to Treatment C, the control group. Each treatment group was made up of an equal proportion of high, average, and low ability subjects.

The Learning Task

Orthographic projection principles and skills were selected as the learning task for this experimental study. Orthographic projection is a graphic method by means of which the precise shape of an object may be represented in one or more views on a flat plane. Subjects were taught 1) the names and locations of the six possible views used in this system of projection; 2) the methods of revolving an object to produce these views; 3) the projection principles that enable one to transfer shapes and measurements from one view to another; 4) the representation of normal, inclined, and curved surfaces; and 5) line symbols representing projection lines and visible and invisible features. The taped instruction was related to a workbook of problems which the students solved as the instruction was presented.

Instruction

Subjects were taught in groups of twenty-one. Each group was composed of seven subjects from high, average, and low ability levels. The subjects received forty-three minutes of instruction. The first eight minutes of instruction was identical for Treatments A and B. The remaining thirty-five minutes of instruction was devoted to differential treatments. All instruction was taped and related to a workbook of problems. The control group, Treatment C, did not receive instruction. However, this group did complete the criterion tests.

Testing

Three testing periods were employed during this experiment. An initial learning test (fifty minutes) was administered immediately following the instruction. Retention (fifty minutes) and transfer (fifty minutes) tests were administered one and six weeks after treatment. All subjects completed the five criterion tests with time to spare.

Intercorrelations between total test scores ranged from .74 to .86. Reliability coefficients ranged from .86 to .96 as determined by split-halves corrected by the Spearman-Brown Prophecy Formula.

Findings

On the basis of appropriate statistical tests the researcher found:

1. in terms of initial learning, transfer one week, and retention one and six weeks, there were no statistically significant differences between the total Treatment A and Treatment B groups.
2. with reference to transfer as measured six weeks after treatment, the total Treatment B group was superior to the Treatment A group.
3. that the groups receiving Treatments A and B proved statistically superior on all criterion tests in comparison with the uninstructed control group.
4. no evidence of interaction between the two methods of organizing taped instruction and ability levels.
5. that the average ability group receiving Treatment B was superior to the average ability group receiving Treatment A in regard to performance on a retention test administered six weeks after instruction.

6. that the low ability group receiving Treatment B was superior to a comparable ability group receiving Treatment A in transferring projection principles and skills as measured six weeks after treatment.
7. that the Treatment B group performed at a statistically significant higher level on a test of retention administered one week after instruction in contrast with performance on the identical test administered immediately after instruction.
8. that the Treatment A group showed a statistically significant gain on the retention one week test in contrast to performance on the identical test administered immediately after instruction.
9. that the Treatment B group performed at a statistically significant higher level on a test of retention administered six weeks after instruction in contrast with performance on the identical test administered immediately after instruction.
10. that there was no significant gain in performance by the Treatment A group on the retention six weeks test in contrast with performance on the initial learning test.
11. that there was no significant gain in performance by the Treatment A group on the transfer six weeks test in contrast to performance on the transfer one week test.
12. that the Treatment B group performed at a statistically significant higher level on the transfer six weeks test in comparison with performance on the transfer one week test.

Conclusions

1. The direct-detailed and directed discovery methods are equally effective in regard to the initial learning of orthographic projection principles and skills and to the retention of this content as measured one and six weeks after instruction.

2. The direct-detailed and directed discovery methods are equally effective in terms of transferring projection principles and skills as measured one week after treatment.
3. The directed discovery method is superior with reference to transferring projection principles and skills as measured six weeks after instruction.
4. There is no interaction between methods and ability levels.
5. The direct-detailed and directed discovery methods of organizing taped instruction are productive of learning that is usable immediately after instruction, and that persists for at least six weeks after instruction in regard to the retention and transfer of orthographic projection principles and skills.
6. With reference to specific ability levels the directed discovery method is superior for average subjects in regard to the retention of orthographic projection principles and skills six weeks after instruction.
7. With reference to specific ability levels the directed discovery method is superior for low ability subjects in terms of transferring projection principles and skills six weeks after instruction.
8. The directed discovery method is productive of significant gains in performance on tests of retention administered one and six weeks after treatment in contrast with the subjects' performance on the identical test administered immediately after instruction.
9. The direct-detailed method is productive of a significant gain in performance on a retention one week test in contrast with performance on the initial learning test; however, there is no significant gain between retention six weeks and initial learning.
10. The direct detailed method is not productive of a statistically significant gain on the transfer six weeks test in comparison with performance on the identical test administered one week after instruction.

11. The directed discovery method is productive of a statistically significant increase in performance on the transfer six weeks test in contrast with performance on the identical test administered one week after instruction.

Limitations

The formulation of generalizations applicable to the organization of taped instruction should be tempered and carefully weighed in view of the following limitations:

1. The learning task employed in this experiment was primarily cognitive. Manipulative tasks were incidental consisting of sketching lines to complete problems and revolving three-dimensional blocks. However, the fact that students were engaged in physical responses to the auditory stimuli should not be disregarded as unimportant.
2. The teaching-learning process was limited in that subjects were not informed concerning the accuracy of their resopnses to the problems in the workbook.
3. The subjects were not permitted to examine the corrected criterion tests. The omission of a feedback of information, although a procedure followed for control purposes, nevertheless denied the subjects information which might have been used as a basis for altering responses on the transfer six weeks test and on the tests of retention that were administered one and six weeks after treatment.
4. The novelty effect of receiving instruction in a manner quite different from that to which the subjects had become accustomed may have influenced performance independent of the methods of organization employed.
5. The subjects were not held accountable for their performance in the sense that their efforts were translated into, and became a part of, a final grade in a college course. Had it been possible to couple the extrinsic motivation associated with the goal of achieving a "high" grade with the intrinsic motivation that was present, the scores, irrespective of methods, may have been increased.

2

6. Communication between subjects during the course of the experiment almost certainly occured since all subjects were enrolled at the same college. However, there is nothing to suggest that one treatment group was in a more advantageous position than another to profit from or be inhibited by information relative to the experiment that may have been transmitted by other subjects.

Implications for Further Research

1. While the control of extraneous variables may be more easily accomplished in a research design of the type employed in this study, there would be merit in a longitudinal study to compare the cumulative effects of the direct-detailed and directed discovery methods of organizing taped instruction.
2. A modification of the type of research design employed in this study to facilitate a feedback of information to the subjects could be accomplished by employing a tab-type criterion test.
3. It seems that there would be merit in replicating the present research design using subjects at several age levels. There is a possibility that older subjects may not respond as well initially to the directed discovery method as those who are younger and perhaps more flexible.

Educational Implications

The historic role of the college professor has been one of guiding and directing the efforts of young people in such a manner that reasonable competence in the subjects being studied is the expected or desired end-product. If one were to trace the evolution of pedagogy at the college level from its primitive origins to the post World War II years, one would find a diversity of techniques that have been employed to promote learning. However divergent these techniques may have been, there was usually one commonality, a professor meeting with a group of students in a classroom or laboratory.

This research has demonstrated that effective and efficient learning can be accomplished in a classroom without the physical or visual presence of the professor. Previous research including recent research involving teaching machines supports this general finding. It should be emphasized that the subjects in this experiment, irrespective of method of organization, were superior to those in the uninstructed group when tested immediately after instruction and at later intervals of one and six weeks. Furthermore, subjects receiving directed discovery instruction significantly improved their scores on tests administered one and six weeks after instruction when comparisons of their performance on the following tests were made: 1) initial learning and retention one week, 2) initial learning and retention six weeks, and 3) transfer one and six weeks. Although slight gains were made by the direct-detailed group at each of the testing intervals, a significant gain was noted only in regard to a comparison of performance on the initial learning and retention one week test.

If it is reasonable to assume that a student may learn, retain, and transfer skills and knowledge as a consequence of taped instruction, then it seems to follow that the resources at the disposal of a professor need not be restricted to the students who come to his class for instruction nor to those who read his books and journal articles. The possibilities of using tapes prepared by recognized scholars to supplement regular classroom instruction is worthy of serious consideration.

There are undoubtedly units of work in many subjects that may be introduced, at least, if not rather fully treated, through the use of taped instruction supplemented by whatever educational aids and techniques seem psychologically sound in regard to the learning task. The scope of the possibilities of this instructional procedure will become apparent only as researchers and teachers direct their efforts to the task of 1) using and 2) evaluating the effectiveness of this medium in contrast with other media.

Taped instruction seems to hold genuine promise for independent study. Although much has already been accomplished in this area, particularly in foreign language instruction, there are many subjects to which little effort has been made in this direction.

The possibility of making available key presentations for remedial instruction should be exploited. Although the present study made no provisions for this procedure, it seems logical that many students might profit from such an opportunity.

Teachers in subject matter areas involving technical and manipulative skills have seemed reluctant to employ taped instruction. A careful study of the learning tasks involved may reveal that taped instruction may be an effective supplement to existing methods of presentation if not a replacement of some of them. In the area of technical drawing, for example, it seems plausable that many of the important lectures may be keyed to workbooks in a manner similar to the one prepared for this study or to slides, charts, or other illustrations.

In the quest for more efficient and effective methods of directing learning activities, teachers and researchers must be both flexible and perceptive as they employ new, and at the onset, seemingly redical instructional techniques. The implications of this and previous research (25) suggest that a method of organizing taped instruction that is inferred from gestalt learning theory is superior to a second method that has its basis in connectionist learning theory. It is axiomatic, in terms of most learning theories, that subjects must respond to stimuli related to the task if learning is to take place. The learning task in this research required subjects to respond to auditory stimuli and relate this to the visual stimuli of three-dimensional objects and problems in the workbook. The directed discovery method appears to be productive of a higher order of response, of a greater degree of personal involvement with the learning task, and consequently, of more effective learning.

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APPENDIX A

TYPESCRIPT OF TAPED INSTRUCTION

General Instructions

You are participating in a research study designed to evaluate methods of organizing instruction to be presented by tape recording. A number of outstanding colleges and universities are conducting similar studies. When the results of these studies are analyzed it is believed that college teachers will be able to use the findings in improving the effectiveness of their instruction. For example, tape recordings of important lectures can be made available for students who may profit from additional study, for those who are absent from class, or for those who wish to review in preparation for an examination.

In order to develop methods of organizing taped instruction it is necessary to actually present taped instruction to students and then evaluate the quality of learning that occurs. A principle from the fields of biology, physics, chemistry, or mathematics might have been chosen for you to study today, but many of you have had high school and college instruction related to these subjects. Instead, a learning task has been selected with which freshman girls are not usually familiar. The validity of the findings requires that you be uninformed relative to the learning task.

The principle that we will study today is the principle of orthographic projection. It is the most important principle that is used by people who make and read mechanical drawings. The architects who planned the fine buildings being constructed on Eastern's campus and the engineer who designed the tape recorder that carries my voice relied on this principle to transmit their ideas to others.

In studying the principle of orthographic projection we will use small, simple objects, and we will see how this principle enables us to describe their shapes in a very accurate and systematic manner. You are requested to talk with no one during the session today. It is very important that you observe this request.

Turn to page one of your workbook. (pause) You will observe two types of drawings on this page. The pictorial drawing on the upper half of the page will be used only as it assists you in developing an understanding of the principle of orthographic projection. On the lower half of the page is an orthographic drawing. It is with this type of drawing that the instruction today is concerned.

Select block number one from those on your desk. (pause) Study the block in relationship to the pictorial drawing. (pause) The front surface of the pictorial drawing labeled "A" corresponds to the front view orthographic drawing. You will note that the orthographic front view is an "L" shaped surface. This is the surface that is visible when one looks directly at the front surface of the block. Take the block in your hand and look directly at the front surface. (pause) You will note, in looking at the block in this manner, that the thickness of the block is not visible. In a similar manner the front view orthographic drawing does not show thickness; it shows only the height, length, and shape of the front view.

Place the block in its correct position over the front view orthographic drawing. (pause) Note that the outline of the drawing conforms to the shape of the block. (pause) In preparing the front view of an orthographic drawing one studies the front view of the block and then draws that which is visible. Study again the front view of the block and compare what you see with the front view orthographic drawing. (pause)

In preparing an orthographic drawing a system of line values is used in describing the object. The only line from the system employed in this front view orthographic drawing is the object line. We represent the lines of the object which we can actually see when looking directly at the front view, or any view for that matter, by using object lines. An object line is always drawn as a heavy, solid line. It is important that all object lines of a view be drawn; otherwise, the drawing is incorrect. Turn to page two of your workbook. (pause)

You will note that we are still concerned with block number one. However, an additional orthographic view has been drawn. This is the top view. The top view of an orthographic drawing is always drawn directly above the front view. The top view shows the depth or thickness of the object. The top view is that which one sees when looking directly at the top of the object.

Take block number one in hand and look directly at the top view of the object. (pause) Note that a line exists on the object as a consequence of a portion of the object being cut away. The cut produces two distinct surfaces represented by "B" and "C" in both the pictorial and orthographic drawings.

Place the block in the correct position over the front view. (pause) Now slowly revolve the object towards you until the top of the object comes in to view. (pause) Place the object in the correct position over the top view. (pause) Study the red projection lines one, two, and three extending from the front view to the top view. (pause) These lines serve an important function. They first insure that the top view will be aligned properly over the front view. In addition, projection lines enable one to transfer measurements and shapes from one view to the other. For example, projection line two, originating in the front view, locates the object line in the top view that distinguishes surface "B" from surface "C". (pause) You will note that all lines in the top view are object lines. (pause)

Turn to page three of your workbook. (pause) You will note that we are still concerned with block number one. In addition to the front and top views which you have previously studied a third view has been added. This is the right side view. (pause) In both the pictorial drawing and the orthographic right side view the surfaces that appear in this view are labeled "D" and "E". The right side view is always located to the right of the front view. Observe that, given top and front orthographic views, the right side view may be solved or drawn by projection. Projection lines seven, eight, and nine, extending from the front view, locate the three horizontal object lines in the right side view. Projection lines five and six are extended from the top view to a forty-five degree miter line and are then projected downward establishing the vertical object lines. When two orthographic views are complete, the third view may be solved entirely by projection.

Place block number one over the front view. (pause) Now slowly revolve the object until the right side comes in to view. (pause) Place the block in the correct position over the right side view. (pause) At this point in the instruction you should understand the locations of the front, top, and right side view orthographic drawings; the method of revolving the object to locate the three views, the use of projection lines, and the purpose of object lines. Return block number one to its place on your desk. (pause)

Problem Two

Treatment A

Turn to page four in your workbook. (pause) Study the pictorial drawing on the upper half of the page. (pause) You will note that six directions of viewing the object are given. (pause) We usually identify or label the front view first. This view tells us as much or more about the shape of the object than any other view. When one view of an object is labeled, such as the front, this automatically identifies the location of the other five views.

Select block number two from those on your desk. (pause) Identify the front view of the block. (pause) It is important to repeat that there is an unchanging and fixed relationship of views involved. Make certain that you understand this relationship.

Direct your attention to the orthographic drawing on the lower half of the page. (pause) You will note that six views have been drawn. These are the six possible views of an orthographic drawing. They correspond to the six views or directions of sight on the pictorial drawing.

The six view orthographic layout is unchanging. For example, the top view is always drawn above the front view. The bottom view is always drawn below the front view, and the left side view is drawn immediately to the left of the front view.

Place block number two in the correct position over the front view. (pause) Next. revolve the block and place it over the top view. (pause) Finally, place the block in the correct position over the right side view. (pause) Return the block to its correct position over the front view. (pause) Revolve the block slowly towards you until the bottom surface comes into view. (pause) When you look directly at the bottom surface of the block the surface appears as a smooth surface. Return the block to its correct position over the front view in the orthographic drawing. (pause) Direct your attention to the bottom view of the orthographic drawing. You will note two broken

Treatment B

Turn to page four in your workbook. (pause) Study the pictorial drawing on the upper half of the page. (pause) How many directions of viewing the object are given? (pause) We usually identify or label the front view first. This view tells us as much or more about the shape of the object than any other view. When one view of an object is labeled, such as the front, this automatically identifies the location of the other five views.

Select block number two from those on your desk. (pause) Can you identify the front view of the block? (pause) Direct your attention to the orthographic drawing on the lower half of the page. How many views have been drawn? (pause) These are the six possible views of an orthographic drawing. Is there a relationship between the six views of the orthographic drawing and the six directions of sight on the pictorial drawing? (pause)

The six view orthographic layout is unchanging. For example, the top view is always drawn above the front view. Which view is always drawn below the front view? (pause) Which view is always drawn to the left of the front view? (pause)

Place block number two in the correct position over the front view. (pause) There is a system of revolving the block to produce the six orthographic views. Using the front view as a starting point, can you figure out the system of revolving the block to produce the remaining five views? (long pause)

Can you place the block in its correct position over the top view? (pause) Can you place the block in its correct position over the right side view? (pause) Can you revolve the block until you can look directly at the bottom view? (pause) Return the block to its correct position over the front view. (pause)

Direct your attention to the bottom view of the orthographic drawing. You will note two broken lines in this view. These are called hidden lines. A hidden line is the same as an object line with one important exception: we cannot see that portion lines in this view. These are called hidden lines. A hidden line is the same as an object line with one important exception: we cannot see that portion of the object which it represents in the view that we are considering. To illustrate this point, place the block in its correct position over the bottom view. (pause) All that you can really see when looking at this surface is a rectangle. However, we want to show the lines created by the notches in the block as shown in the front view. We do this by drawing two hidden lines. It is very important that each view of an orthographic drawing be complete. This means that all hidden lines and all object lines that belong in the various views must be drawn in their proper locations.

Place the block in the correct position over the front view. (pause) Note that projection lines three and four establish two object lines in the top view and two hidden lines in the bottom view. To reemphasize a point, the object lines are placed in the top view because they are visible when one looks directly at the top of the object. In the bottom view the lines are broken because they exist but cannot be seen in that view.

Direct your attention now to the left side view. You will note that projection lines one and two establish hidden lines in this view. The notches in the front view account for the hidden lines. You will note, however, that projection lines one and two establish object lines in the right side view.

The sixth and final orthographic view to be explained is the rear view. The rear view is always drawn to the left of the left side view. The rear view is a reversal of the front view.

Before leaving block number two let's make certain that you understand the method of revolving the block to establish the six orthographic views. Place the block in the correct position over the front view. (pause) Revolve the block and place it over the top view. (pause) Return the block to the front view. (pause) Revolve the block and place it over the bottom view. (pause) Return the block to the front view. Revolve the block

of the object which it represents in the view we are considering. Place the block in its correct position over the bottom view. (pause) All that you can really see is a rectangle. However, we want to show the lines created by the notches in the block as shown in the front view. We do this by drawing two hidden lines. It is very important that each view of an orthographic drawing be complete. This means that all hidden lines and all object lines that belong in the various views be drawn in their proper locations.

Place the block in the correct position over the front view. (pause) Projection lines three and four establish object lines in the top view. Why are they object lines? (pause) Projection lines three and four establish hidden lines in the bottom view. Why? (pause)

Direct your attention to the left side view. Why are hidden lines established by projection lines one and two? (pause) Why are object lines established by projection lines one and two in the right side view? (pause)

The sixth and final orthographic view to be considered is the rear view. Is the rear view a reversal of the front view? (pause)

Before leaving block number two let's make certain that you understand the method of revolving the block to establish the six orthographic views. Place the block in its correct position over the front view. (pause) Can you revolve the object and place it correctly over each of the remaining five views? (long pause) Return block number two to its place on your desk. (pause) and place it over the right side view. (pause) Return the block to the front view. (pause) Revolve the block and place it over the **left** side view. (pause) Revolve the block again until the rear view appears and place the block over the rear view. (pause) The system of revolving an object to locate the six views is extremely important. Return block number two to its place on your desk. (pause)

Problem Three

Treatment A

Turn to page five in your workbook. (pause) You will observe the conventional six view orthographic layout. Select block number three from those on your desk. (pause) Place the block over the front view. (pause) Direct your attention to the left side view of the orthographic drawing. You will note that a hidden line has been omitted in this view. Using projection line one as a guide, and the pencil provided you, draw the hidden line in the left side view. (pause) Make certain that it is a broken line. (pause) The left side view is now complete.

Direct your attention to the bottom view. A hidden line is missing in this view. Using projection line two as a guide, draw the hidden line in the bottom view. (pause) The bottom view is now complete. All six views of the orthographic drawing are complete.

Direct your attention to surface "A" in the pictorial drawing. Surface "A" is a normal surface. In a three view drawing involving front, top, and right side views, a normal surface appears as a surface in one view, and as a straight line in each of the other two views. Direct your attention to the front view of the orthographic drawing. Surface "A" appears as a surface in the front view. (pause) In the top view surface "A" appears again as a straight line.

Direct your attention to surface "B" in the pictorial drawing. Surface "B" is an inclined surface. In a three view orthographic drawing involving front, top, and right side views, an inclined surface appears as a surface in two views and as a straight line in the third. Direct your

Treatment B

Turn to page five in your workbook. (pause) You will observe the conventional six view orthographic layout. Select block number three from those on your desk. (pause) Place the block over the front view. (pause) Is a line missing in the left side view? (pause) Is a line missing in the bottom view? (pause) Draw the missing line in the bottom view. (pause) Did you use an object line or a hidden line? (pause)

Direct your attention to surface "A" in the pictorial drawing. Surface "A" is a normal surface. In a three view drawing involving front, top, and right side views, a normal surface appears as a surface in one view and as a straight line in the other two views. Locate surface "A" in the front, top, and right side views. (pause)

Direct your attention to surface "B" in the pictorial drawing. Surface "B" is an inclined surface. In a three view orthographic drawing involving front, top, and right side views, an inclined surface appears as a surface in two of the views and as a line in the third. Locate inclined surface "B" in the front, top, and right side views of the orthographic drawing. (pause) Return block number three to its place on your desk. (pause) attention to the front view of the orthographic drawing. You will note that surface "B" appears as a straight line in the front view. Surface "B" must, therefore, appear as a surface in the top and right side views. You will observe that surface "B" does appear as a surface in each of these views. (pause) Return block number three to its place on your desk. (pause)

Problem Four

Treatment A

Turn to page six in your workbook. (pause) Select block number four from those on your desk. (pause)

Study the top view of the block. (pause) You will recognize that the top view in the orthographic drawing is incomplete. Projection lines one and two locate two missing lines in the top view. Projection line one locates a hidden line. Draw the hidden line in the correct position. (pause) Make certain that it is a broken line. Projection line two locates an object line in the top view. Using projection line two as a guide draw the object line in the top view. (pause) Make certain that it is a solid line. The top view is now complete.

Study the bottom view of the block and the bottom view of the orthographic drawing. (pause) You will note that the bottom view is incomplete. Projection line one locates an object line in the bottom view. Using projection line one as a guide, draw the object line in the bottom view. (pause) Projection line two locates a hidden line in the bottom view. Draw the hidden line in its correct position. (pause) Make certain that it is a broken line. The bottom view is now complete. These six views describe precisely the shape of block four.

Direct your attention to surface "A" in the pictorial drawing. Surface "A" is a normal surface. In fact, all of the surfaces on block number four are normal. Return block number four to its position on your desk. (pause)

Treatment B

Turn to page six in your workbook. (pause) Select block number four from those on your desk. (pause)

Study the top view of the block and the top view of the orthographic drawing. (pause) Do projection lines one and two locate lines in the top view? (pause) Draw the two missing lines in the top view. (pause) Did you use object lines, hidden lines, or both in completing the top view? (pause)

Study the bottom view of the block and the bottom view of the orthographic drawing. (pause) Draw the missing lines in the bottom view. (pause) Did you use object lines, hidden lines, or both in completing the bottom view? (pause)

Is surface "A" in the pictorial drawing a normal surface? (pause) Return block number four to its position on your desk. (pause)

Problem Five

Treatment A

Turn to page seven in your workbook. (pause) Select block number five from those on your desk. (pause) Study block number five in relationship to the pictorial drawing and identify each surface of the block. (pause) Place block number five in the correct position over the front view. (pause) Direct your attention to the right side view. (pause) A hidden line is missing in this view. Projection line one locates the hidden line. Draw the hidden line in the right side view. (pause) The right side view is now complete. Direct your attention to the left side view. (pause) An object line is missing in this view. Using projection line one as a guide, draw the missing object line in the left side view. (pause) The left side view is now complete. Direct your attention to the bottom view of the orthographic drawing. The notch which appears in the front view has not been represented in the bottom view. Projection line two locates the missing object line in the bottom view. Draw the object line in the correct location. (pause) The bottom view is now complete in every detail. All hidden lines and all object lines are in their correct positions.

Direct your attention to the pictorial drawing. Surface "A" is an example of a normal surface. Surface "B" is an inclined surface. In the orthographic drawing surface "A" appears as a surface in the front view, and as a straight line in the top and right side views. In the orthographic drawing surface "B" appears as a line in the front view and as a surface in the top and right side views. Return block number five to its position on your desk. (pause)

Treatment B

Turn to page seven in your workbook. (pause) Select block number five from those on your desk. (pause) Can you look at block number five and identify each of the six views? (pause) Place block number five in the correct position over the front view. (pause) Locate projection line one. (pause) Does projection line one locate a missing line in both the left side and right side views? (pause) Draw the missing lines. (pause) Did you use object lines, hidden lines, or both in completing the left and right side views? (pause)

Is the bottom view of the orthographic drawing complete? (pause) Draw the missing line in the bottom view. (pause) Did you use an object or a hidden line to complete the bottom view? (pause)

Direct your attention to the pictorial drawing. What type of surface is surface "A"? (pause) What type of surface is surface "B"? (pause) Return block number five to its position on your desk. (pause)

Problem Six

Treatment A

Turn to page eight of your workbook. (pause) Select block number six from those on your desk. (pause) Study block number six and its relationship to the pictorial drawing. (pause)

Treatment B

Turn to page eight of your workbook. (pause) Select block number six from those on your desk. (pause) Study the block in relationship to the pictorial drawing. (pause) Is surface "A" normal

Locate surface "A" on the block. (pause) Surface "A" is a normal surface. Locate surface "B" on the block. (pause) Surface "B" is an inclined surface. Direct your attention to the six view orthographic drawing. (pause) Place block number six in the correct position over the front view. (pause) Both the top and rear views are incomplete. (pause) A hidden line connecting points "X" and "Y" will complete the rear view. Draw the hidden line in the rear view. (pause) The hidden line which you have drawn in the rear view represents surface "B". The rear view is complete. Direct your attention to the top view. (pause) The notch, which appears in the front view, has not been represented in the top view. Projection line one which locates the vertical hidden line in the bottom view locates a vertical object line in the top view. The vertical object line is drawn between horizontal object lines two and three in the top view. Draw the object line in its correct position. (pause) The top view is complete.

Before leaving this problem observe the functions of projection lines two and three. You will note that these projection lines operate in a systematic manner between the top, left side, bottom, and right side views. Object line two in the top view can be traced, systematically, to the left side view where we observe a hidden line, to the bottom view where another hidden line is drawn, and finally, to the right side view where an object line is present. This is a striking example of the principle of orthographic projection. A line in one view, which represents a feature of an object, may be projected to several other views in an accurate manner.

Locate projection line four. (pause) Observe that projection line four locates an object line in the rear view, a hidden line in the left side view, and object line in the front view, and an object line in the right side view. This is another example of the principle of orthographic projection. Return block number six to its place on your desk. (pause)

or inclined? (pause) Is surface "B" normal or inclined? (pause)

Direct your attention to the six view orthographic drawing. (pause) Place block number six in the correct position over the front view. (pause) Is a line missing in the top view? (pause) Projection lines one, two, and three will assist you in locating the line. (pause) Draw the missing line. (pause) Did you use an object or a hidden line in the top view? (pause)

Is a line missing in the rear view? (pause) Draw the missing line in its correct location. (pause) Did you use an object or a hidden line in completing the rear view? (pause)

Study projection line two. (pause) How does it function between the top, left side, bottom, and right side views? (pause)

Study projection line four. (pause) How does projection line four function between the rear, left side, front, and right side views? (pause) Return block number six to its position on your desk. (pause)

Problem Seven

Treatment A

Turn to page nine in your workbook. (pause) Select block number seven from those on your desk. (pause)

Place the block in its correct position over the front view. (pause) All of the orthographic views of this problem are complete. However, a third type of surface appears in this problem, a curved surface. Locate curved surface "C" in the pictorial drawing. (pause) Note that surface "C" flows smoothly into normal surface "A". A line is never drawn where these surfaces join. If you will examine the block you will see that a line does not appear at this intersection. (pause) In a three view orthographic drawing involving front, top, and right side views, a curved surface appears as a line in one view and as a surface in the other two views. Surface "C" appears as a line in the front view and as a surface in both the top and right side views.

Note the manner in which the hole, which is shown by true circles in the rear and front views, is represented in the other four views. (pause) Projection lines one and two, extending from the extremities of the circle in the front view, locate the hidden lines in the top and bottom views. (pause) In a similar manner projection lines three and four locate the hidden lines in the left and right side views. (pause) Return block number seven to its position on your desk. (pause)

Treatment B

Turn to page nine in your workbook. (pause) Select block number seven from those on your desk. (pause) Place the block in its correct position over the front view. (pause) Locate curved surface "C" in the pictorial drawing. (pause) Notice that surface "C" flows smoothly into surface "A". A line is never drawn where these surfaces join. In a three view orthographic drawing involving front, top, and right side views, a curved surface appears as a line in one view, and as a surface in the other two views.

Study the six view drawing of block number seven. (pause) Has each feature of the block been represented in the six views? (pause) Return block number seven to its position on your desk. (pause)

Problem Eight

Treatment A

Turn to page ten in your workbook. (pause) Select block number eight from those on your desk. (pause) Study block number eight and identify surfaces "A", "B", and "C". (pause) Surface "A" is a normal surface, (pause) surface "B" is a curved surface, (pause) surface "C" is an inclined surface. (pause)

Direct your attention to the six view orthographic drawing. (pause) place block number eight in position over the front view. (pause) Lines are missing in the rear and top views. You will note that a hidden line is missing in the rear view. Projection line one locates the horizontal hidden line. Draw the hidden line in the correct location. (pause) The rear view is complete.

Direct your attention to the top view of the orthographic drawing. (pause) You will observe that a line is missing in the top view. The missing line is an object line which may be located by projection line two. Draw one horizontal object line in the top view. (pause) Make certain that it is a solid line. The top view is complete. All six views of the orthographic drawing are now complete. Return block number eight to its location on the desk. (pause)

Treatment B

Turn to page ten in your workbook. (pause) Select block number eight from those on your desk. (pause) What types of surfaces are "A", "B", and "C"? (pause) Place block number eight in its correct position over the front view. (pause) Is a line missing in the rear view? (pause) Draw the missing line in the rear view. (pause) Did you use an object line or a hidden line in completing the rear view? (pause)

Is a line missing in the top view? (pause) Add the missing line. (pause) Did you use an object or a hidden line? (pause) Return block number eight to its position on your desk. (pause)

Problem Nine

Treatment A

Turn to page eleven in your workbook. (pause) Select block number nine from those on your desk. (pause) Study the block in relationship to the pictorial drawing. Make certain that you can identify the surfaces of the block. (pause) Place the block over the front view. (pause) Direct your attention to the top view of the orthographic drawing. You will note that two hidden lines are missing in the top view. These are located by projection lines three and four. Draw the hidden lines in the top view. (pause) The hidden lines which you have drawn represent the hole as it appears in the top view. The top view is complete.

Treatment B

Turn to page eleven in your workbook. (pause) Select block number nine from those on your desk. (pause) Study the block in relationship to the pictorial drawing. (pause) Lines are missing in two of the six views. (pause) Projection lines one, two, three, and four will assist you in completing the two views. (pause) Draw the missing lines in the two views. (pause) Did you use object lines, hidden lines, or both in completing the two views? (pause)

Before leaving block number nine check your understanding of the methods of revolving the block to locate the six orthographic views. (long pause) Return block number nine to its position on your desk. (pause)

Direct your attention to the left side view. (pause) You will note that the holes which appear in the front view have not been represented in the left side view. Projection lines one and two locate the missing hidden lines in the left side view. Draw the two hidden lines. (pause) The left side view is complete. All six views of the orthographic drawing are complete.

Before leaving block number nine let's review the method of revolving the object to produce the six views. Beginning with the block over the front view, (pause) revolve it and place the block over the top view. (pause) Return the block to the front view. (pause) Revolve the block and place it over the bottom view. (pause) Return the block to the front view. (pause) Revolve the block and place it over the right side view. (pause) Return the block to the front view. (pause) Revolve the object and place it over the left side view. (pause) Revolve the object and place it over the rear view. (pause) Return block number nine to its position on your desk. (pause)

Problem Ten

Treatment A

Turn to page twelve in your workbook. (pause) Study the three view drawing. (pause) The front and top views of the orthographic drawing are complete. The problem is to complete the right side view. All of the projection lines needed to solve the right side view have been projected to that view. Follow my directions very carefully and I will assist you in solving the right side view.

Locate horizontal projection line two in the top view. (pause) Follow projection line two until it intersects the miter line. (pause) Trace projection line two downward to the right side view. (pause) Projection line two establishes a vertical object line in the right side view. The object line represents normal surface "A" in the right side view. Draw the object line in its correct position. (pause) Direct your attention to projection lines five and six between

Treatment B

Turn to page twelve in your workbook. (pause) Study the three view drawing. (pause) Which view is incomplete? (pause) Projection lines two, five, and six will assist you in completing the right side view. (pause) Draw the missing lines in the right side view. (long pause) Did you use object lines, hidden lines, or both in solving the right side view? (pause) What type of surface is surface "A"? (pause) How is surface "A" represented in the right side view? (pause) the front and right side views. Projection lines five and six establish horizontal hidden lines in the right side view. The square hole that appears in the front view is represented by these two hidden lines in the right side view. Draw the two hidden lines in the right side view. (pause) Make certain that they are broken lines. The right side view is complete.

Problem Eleven

Treatment A

Turn to page thirteen in your workbook. (pause) Study the three view drawing. (pause) The front and right side views are complete. The problem is to complete the top view. Surface "A" is a normal surface. It appears as a line in the front view and as a line in the right side view. It must, therefore, appear as a surface in the top view. Using projection lines one and two in the top view as guides, draw the two horizontal object lines to complete surface "A". (pause) Surface "A" should now appear as a rectangular surface in the top view. The top view is complete.

Treatment B

Turn to page thirteen in your workbook. (pause) Study the three view drawing. (pause) Which view is incomplete? (pause) Projection lines one and two will assist you in drawing the missing lines. Draw the missing lines in the top view. (pause) Did you use object lines, hidden lines, or both in solving the top view? (pause)

Problem Twelve

Treatment A

Turn to page fourteen in your workbook. (pause) Study the three view drawing. (pause) The top and front views are complete. Our problem is to complete the left side view. Surface "A" is a normal surface. Surface "A" appears as a line in the front view and as a line in the top view. It must appear as a surface in the left side view. Using projection lines two and three as guides, draw the two object lines needed to complete surface "A". (pause) Surface "A" should now appear as a surface in the left side view. Surface "B" is a normal surface. It appears as a surface in the front view and as a line in the top view. Surface "B" must therefore appear as a line in the left side view. Projection line four locates the vertical hidden line in the left side view. The

Treatment B

Turn to page fourteen in your workbook. (pause) Study the three view drawing. (pause) Which view is incomplete? (pause) Complete the left side view. (pause) Projection lines two, three and four will assist you. (pause) Did you use object lines, hidden lines, or both in completing the left side view? (pause) line is hidden because surface "A" blocks our view of the line. Draw the hidden line in the left side view. (pause) The left side view is complete.

Problem Thirteen

Treatment A

Turn to page fifteen in your workbook. (pause) The front, top, and right side views are complete. The problem is to complete the bottom view. You will note that the top view has an "L" shape. The bottom view also has an "L" shape but the shape is a reversal of the top view. Using projection lines two and six as guides, complete the "L" shape in the bottom view with object lines. (pause)

Surface "A" is a normal surface. It appears in the front view as a line, and in the right side view as a line. It must, therefore, appear as a surface in the bottom view. Using projection line three as a guide, draw the vertical object line in the bottom view to complete surface "A". (pause) The bottom view is now complete.

Treatment B

Turn to page fifteen in your workbook. (pause) Study the four view drawing. (pause) Which view is incomplete? (pause) Draw the missing lines in the bottom view. (pause) Projection lines two, three, and six will assist you. (pause) Did you use object lines, hidden lines, or both in solving the bottom view? (pause)

Figures One, Two, and Three

Treatment A

Turn to page sixteen in your workbook. (pause) Study figure one at the top of the page. (pause) Direct your attention to figure two. (pause) The front surface of figure two has been identified. Remember, if one surface is identified, this automatically locates the other five views. For example, if you were requested to draw a right side view of figure two, you would view the block from direction three. (pause) If you were to draw a left side view you would use direction two. (pause) To draw a rear view, direction one would be used. (pause)

Study figure three. (pause) The top surface is identified. Given this information we know that direction one will be correct for the front view.

Treatment B

Turn to page sixteen in your workbook. (pause) Study figure one at the top of the page. (pause) Direct your attention to figure two. (pause) The front surface of figure two is labeled. Remember, if one surface is labeled, this automatically locates the other five surfaces. Which is the right side view of figure two? (pause) Which is the left side view? (pause) Which is the rear view? (pause)

Study Figure three. (pause) Which surface is the front view? (pause)

Figures Four, Five, Six, and Seven

Treatment A

Turn to page seventeen in your workbook. (pause) Study figure four. (pause) The left side view of the object is identified. If you were requested to draw a right side view, direction one is the correct line of sight.

Figure five shows four possible right side views of the block we have just studied. (pause) View "B" is incorrect; an object line is missing. (pause) View "C" is incorrect; an object line is missing. (pause) View "D" is incorrect; there are no hidden lines in the right side view. View "A" is correct.

Study figure six. (pause) The right side view has been identified. If you were requested to draw a bottom view, direction one is correct. Figure seven shows four possible bottom views of the object. (pause) View "A" is incorrect; an object line does not appear in the bottom view. (pause) View "B" is incorrect; only a single hidden line appears in the bottom view. (pause) View "C" is incorrect; a hidden line must be drawn to represent the cut in the block. (pause) View "D" is correct, the single hidden line indicates the intersection of normal surface "Y" with inclined surface "X".

Treatment B

Turn to page seventeen in your workbook. (pause) Study figure four. (pause) If you were requested to draw a right side view of the block, from which direction would you view the object? (pause)

Figure five shows four possible right side views of the object we have been studying. Why is view "A" the correct view? (pause) Why are views "C", "B", and "D" incorrect? (pause)

Study figure six. (pause) If you were requested to draw a bottom view of the object, from which direction would you view it? (pause)

Figure seven shows four possible bottom views of the object. Why is view "D" correct? (pause) Why are views "A", "B", and "C" incorrect? (pause)

Figures Eight and Nine

Treatment A

Turn to page eighteen in your workbook. (pause) Study figure eight. (pause) The front and top views of the orthographic drawing are correct. The problem is to select the correct right side view. (pause) View "D" is incorrect; projection line two has not been used to establish a line. View "B" is incorrect. Although projection line two has been used to establish a line, it should not be hidden. (pause) View "C" is incorrect . Projection line two does not establish a line in view "C". In addition, the vertical object line in the center of view "C" has no relationship to the object. View "A" is correct. Projection line two establishes a horizontal object line. An object line is used

Treatment B

Turn to page eighteen in your workbook. (pause) Study figure eight. (pause) The front and top views of the orthographic drawing are correct. Which one of the four possible right side views is correct? (pause) Why is view "A" correct? (pause) Why are views "B", "C", and "D" incorrect? (pause)

Study figure nine. (pause) The front and top views are correct. Which of the four possible left side views is correct? (pause) Why is view "B" the correct left side view? (pause) Why are views "A", "C", and "D" incorrect? (pause) because a line would be visible at this location if one looked at the right side of the object.

Direct your attention to Figure nine. (pause) The front and top views of the orthographic drawing are complete. The problem is to select the correct left side view. View "A" is incorrect. Projection lines one and two have not established lines in view "A". View "D" is incorrect. Although Projection line two locates an object line, projection line one has not been used. (pause) View "C" is incorrect. Hidden lines do not appear in the left side view of this object. (pause) View "B" is correct. Projection lines one and two locate the two object lines which represent the cuts in the block. (pause)

Figures Ten and Eleven

Treatment A

Turn to page nineteen in your workbook. (pause) Study figure ten. (pause) The front and right side views are complete. The problem is to select the correct top view from among the three possible solutions. Top view "A" is incorrect. Projection lines one and two, extending from the right side view, have not been used to establish lines in view "A". (pause) View "B" is incorrect. Although projection lines one and two have been used, the hidden lines are incorrect. These should be object lines. (pause) View "C" is correct. Projection lines one and two establish object lines in top view "C". (pause)

Direct your attention to figure eleven. (pause) The front and right side views are correct. The problem is to select the correct bottom view. View "A" is incorrect. Although projection line one extending from the right side view has been used, the horizontal object line it establishes is incorrect. This lines would not be visible in the bottom view. (pause) View "B" is incorrect. Projection line one has not been employed to establish a line. (pause) View "C" is incorrect. Although a horizontal hidden line appears in the correct bottom view, you will note that the hidden line in view "C" is not an extension

Treatment B

Turn to page nineteen in your workbook. (pause) Study figure ten. (pause) The front and right side views are correct. Which of the three possible top views is correct? (pause) Why is view "C" correct? (pause) Why are views "A" and "B" incorrect? (pause)

Direct your attention to figure eleven. (pause) The front and right side views are correct. Which of the four possible bottom views is correct? (pause) Why is view "D" correct? (pause) Why are views "A", "B", and "C" incorrect? (pause)

This completes the first part of our session today. Make certain that your name is on the cover of the workbook. The materials at your desk will be picked up, and additional materials will be distributed to you. Remember, please talk with no one until the session is over.

from projection line one. View "D", however, is correct. The hidden line has been located by projection line one. This line would not be visible if one looked at the bottom surface of the object. This is the reason for a hidden, rather than an object line.

This completes the first part of our session today. Make certain that your name is on the cover of the workbook. The materials at your desk will be picked up, and additional materials will be distributed to you. Remember, please talk with no one until the session is over.

APPENDIX B

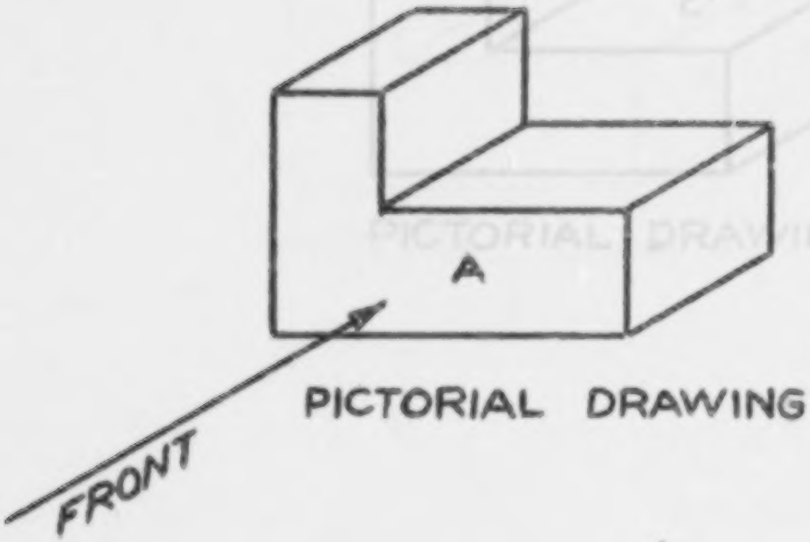
WORKBOOK OF PROBLEMS

Name________________________________ Research Group Number____________

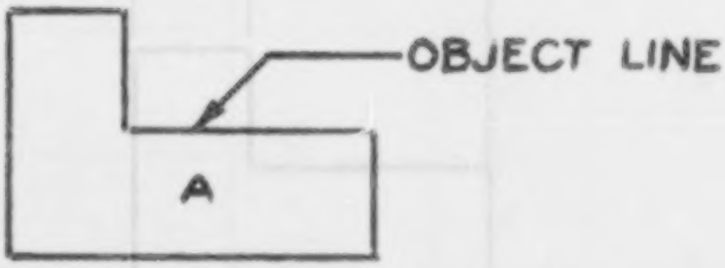
Richmond Mailing Address____

Richmond Residence____
Dorm Room

This is a workbook of problems which will assist you in understanding the learning task which we will consider today. The taped instruction will be related directly to these problems. Directions from the tape recorder will tell you when to open the workbook. Please do not open the workbook until you receive these directions.

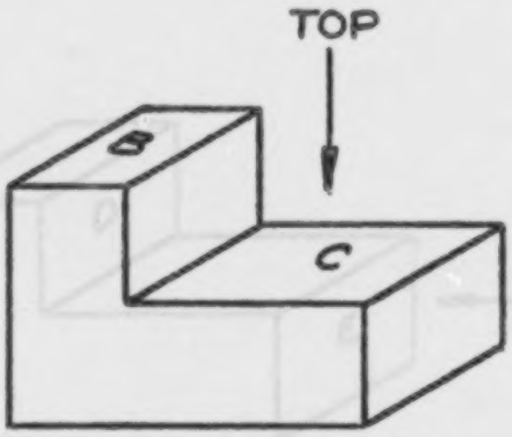


PICTORIAL DRAWING

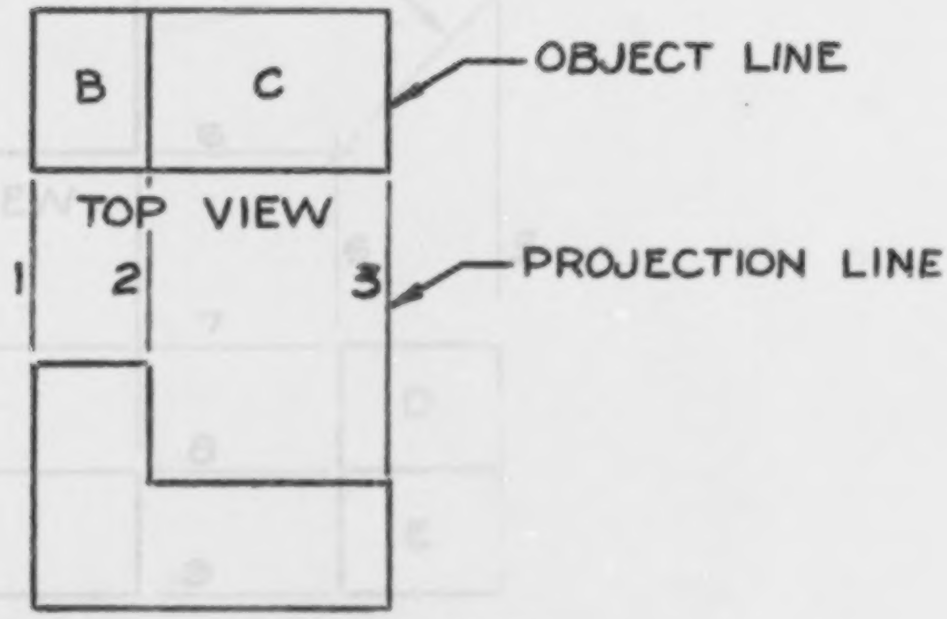

OBJECT LINE
A

FRONT VIEW

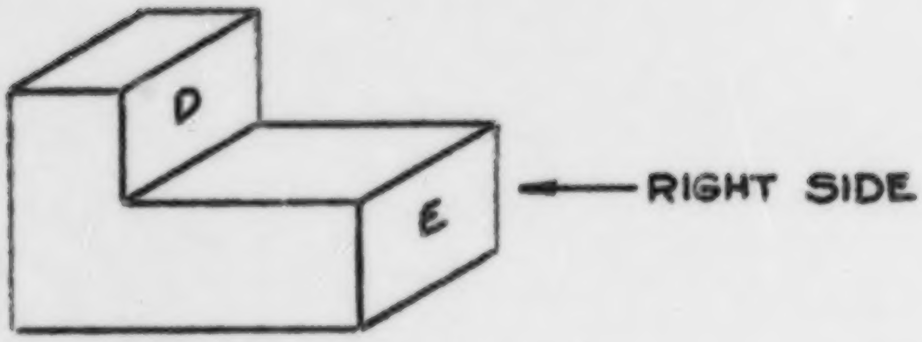
ORTHOGRAPHIC DRAWING



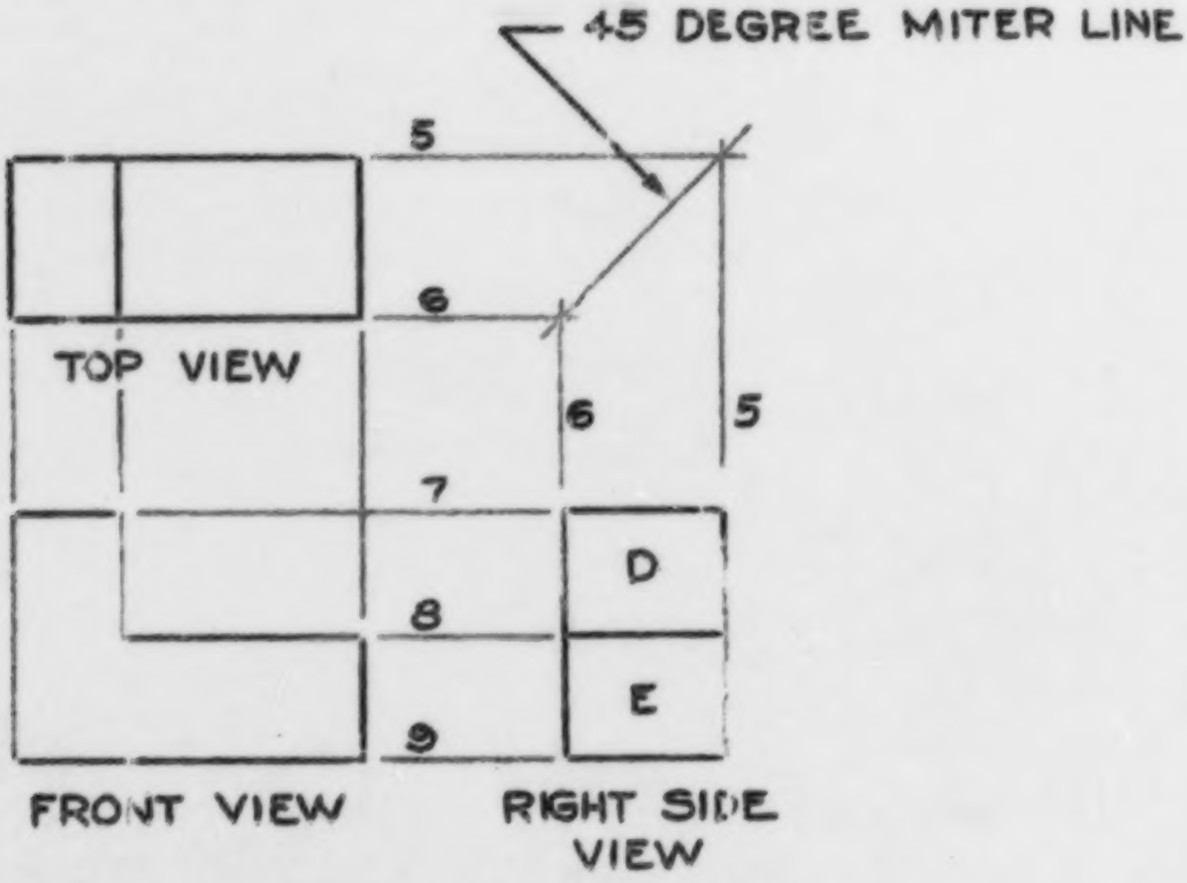
PICTORIAL DRAWING


B
C
OBJECT LINE
TOP VIEW
1
2
3
PROJECTION LINE
FRONT VIEW

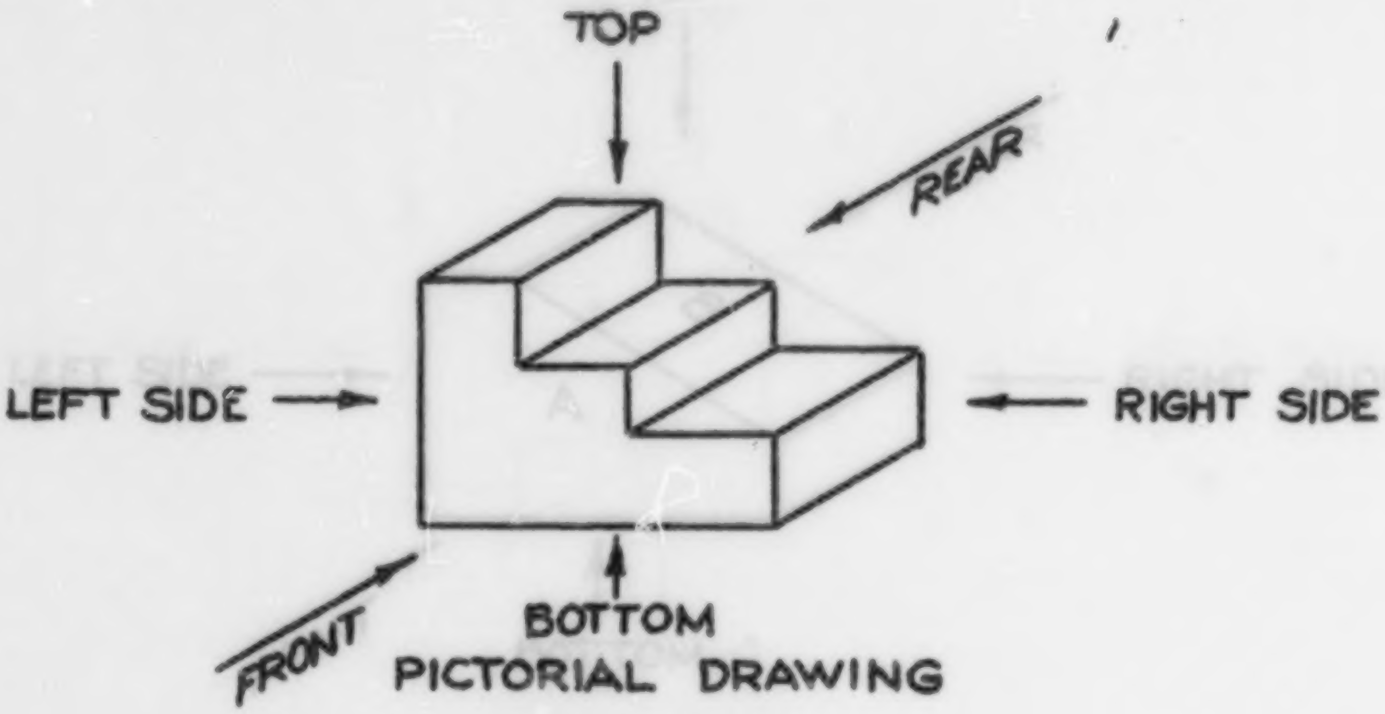
ORTHOGRAPHIC DRAWING


D
E
RIGHT SIDE

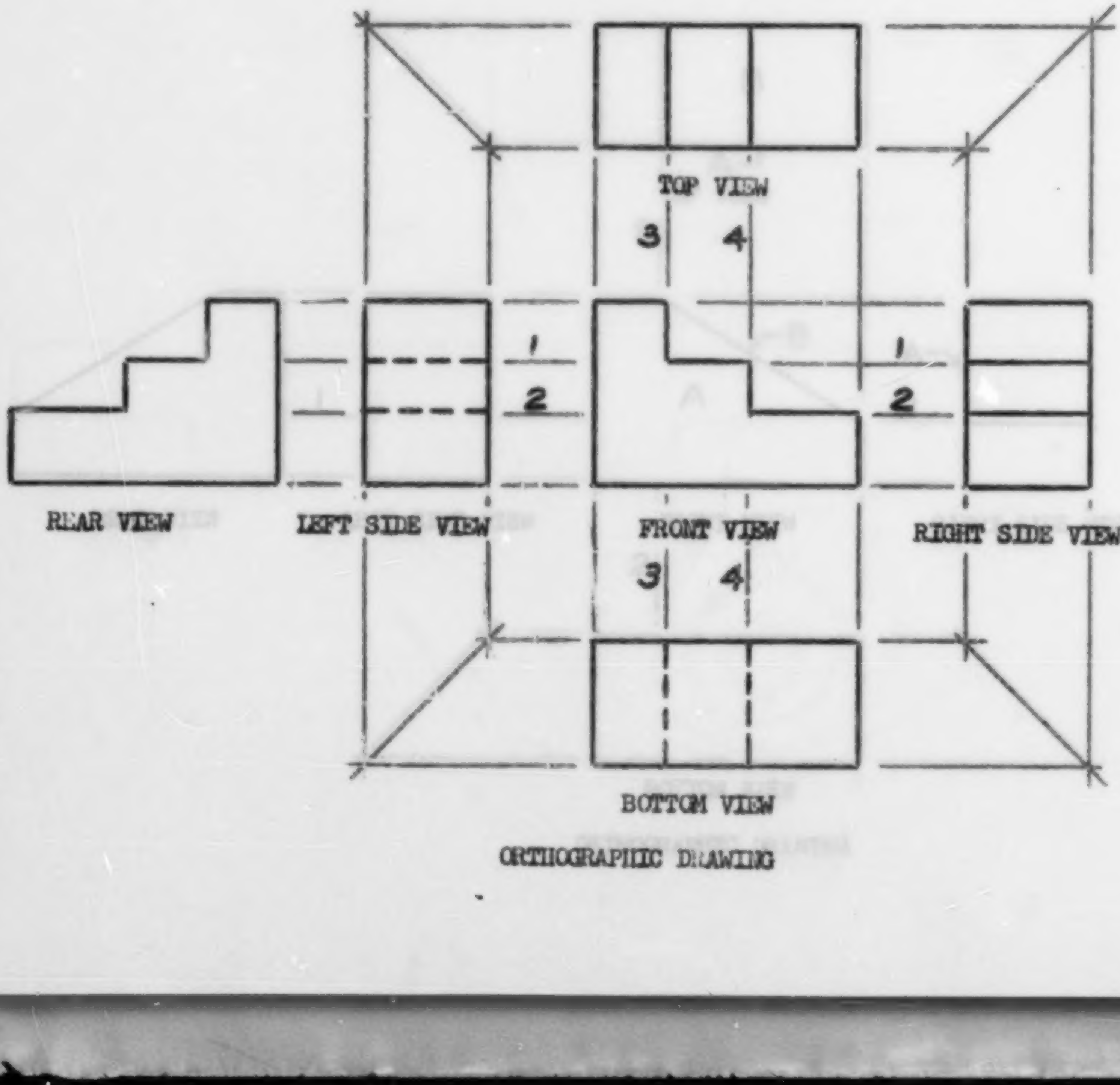
PICTORIAL DRAWING


45 DEGREE MITER LINE
5
6
TOP VIEW
6
5
7
D
8
E
9
FRONT VIEW
RIGHT SIDE VIEW

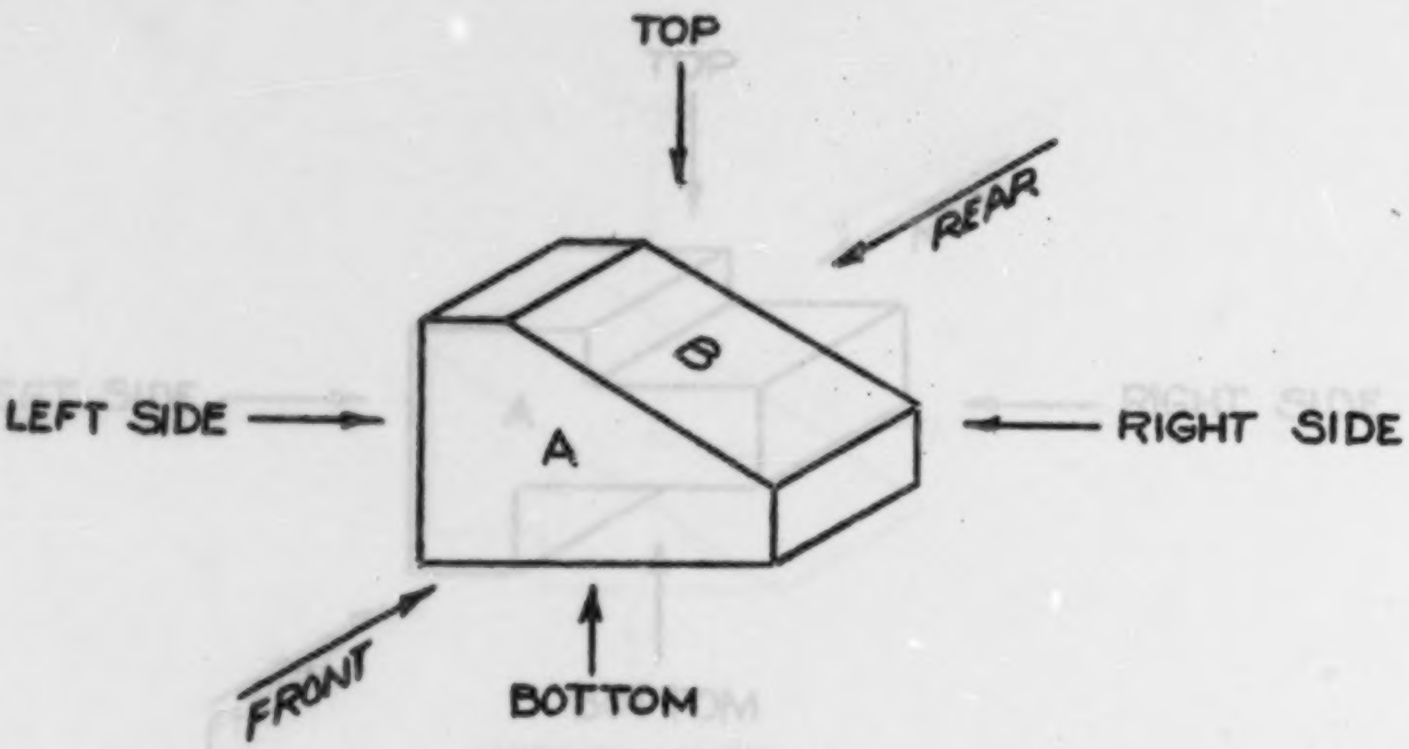
ORTHOGRAPHIC DRAWING

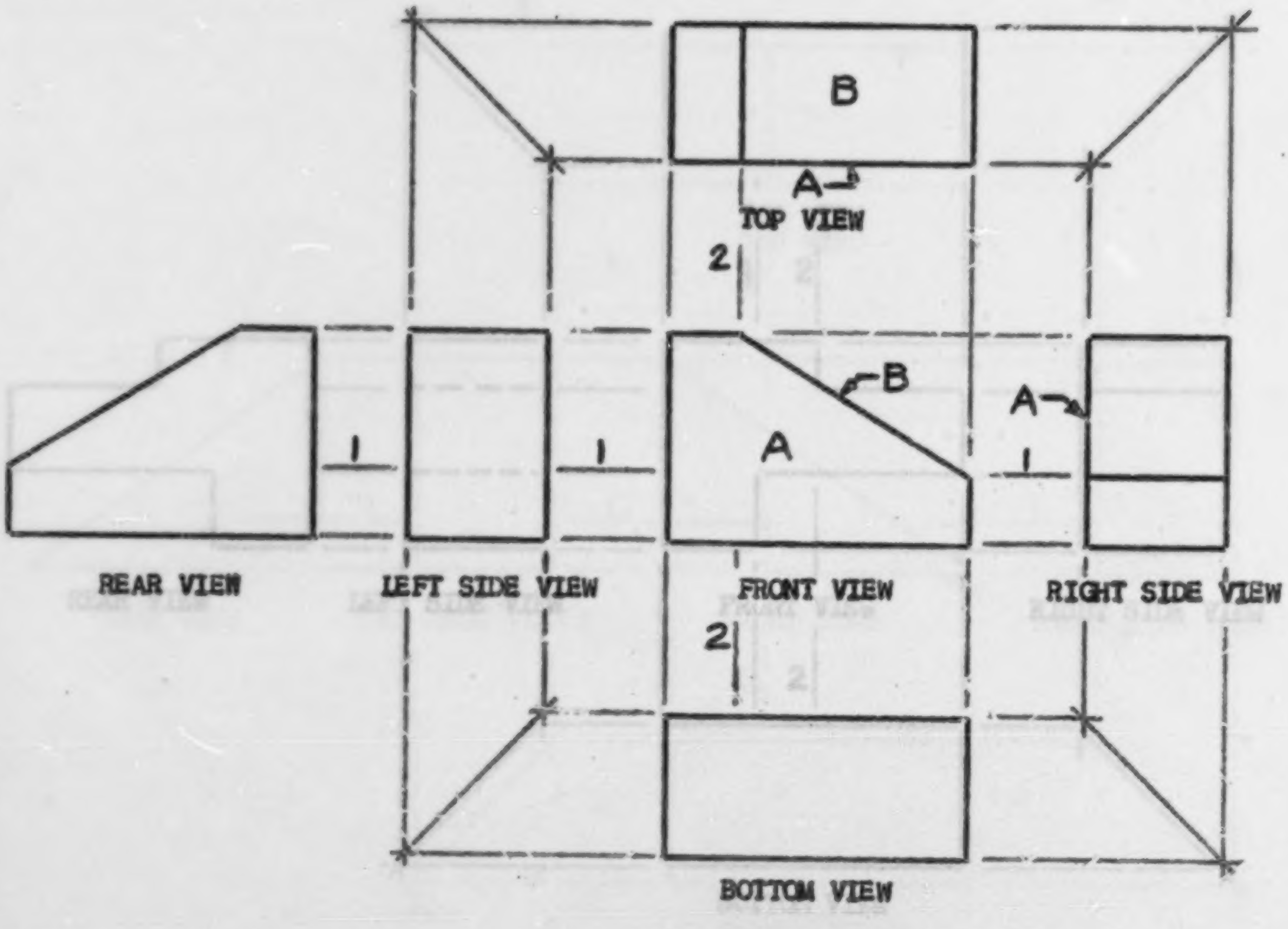

TOP
REAR
LEFT SIDE
RIGHT SIDE
BOTTOM
FRONT

PICTORIAL DRAWING

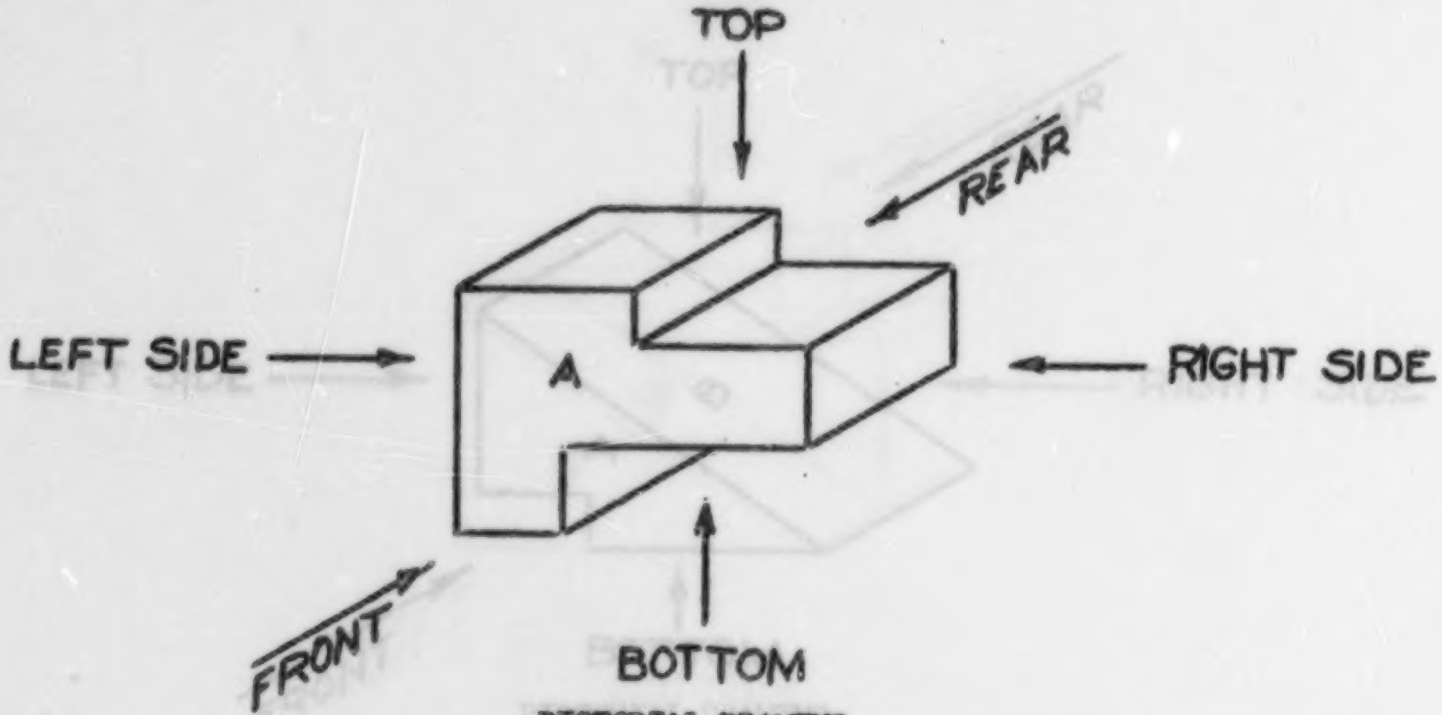

TOP VIEW
3
4
1
2
1
2
REAR VIEW
LEFT SIDE VIEW
FRONT VIEW
RIGHT SIDE VIEW
3
4
BOTTOM VIEW

ORTHOGRAPHIC DRAWING

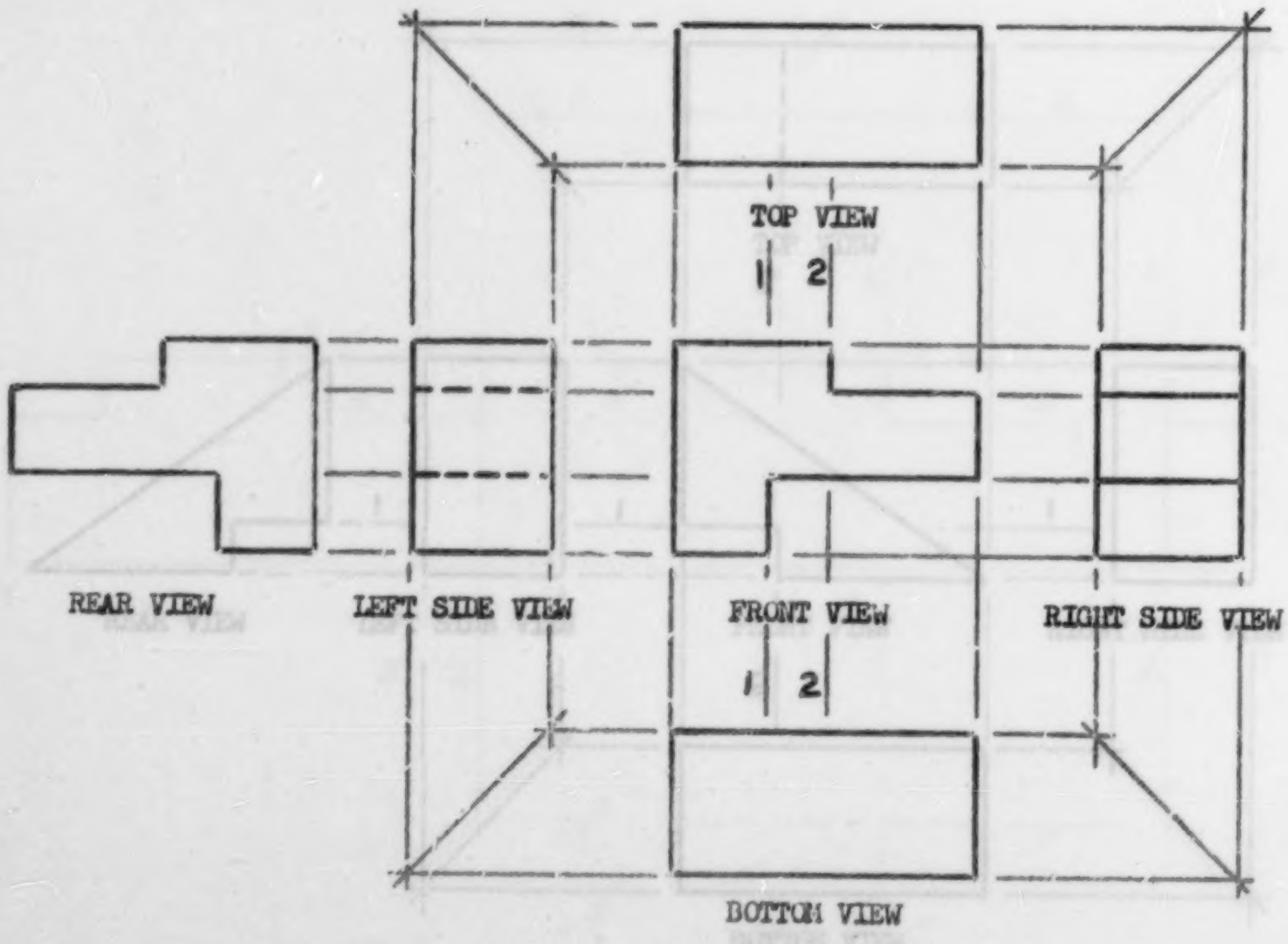

TOP
REAR
B
LEFT SIDE
A
RIGHT SIDE
FRONT
BOTTOM


B
A
TOP VIEW
2
1
1
B
A
A
1
REAR VIEW
LEFT SIDE VIEW
FRONT VIEW
RIGHT SIDE VIEW
2
BOTTOM VIEW

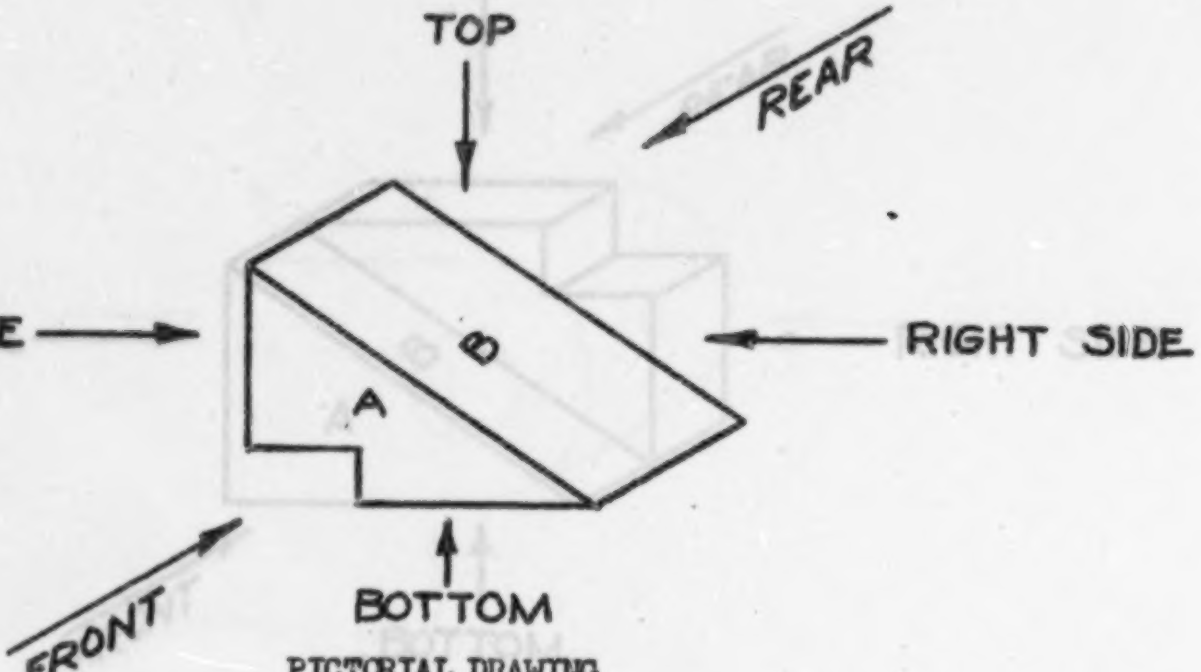
ORTHOGRAPHIC DRAWING


TOP
REAR
LEFT SIDE
A
RIGHT SIDE
FRONT
BOTTOM

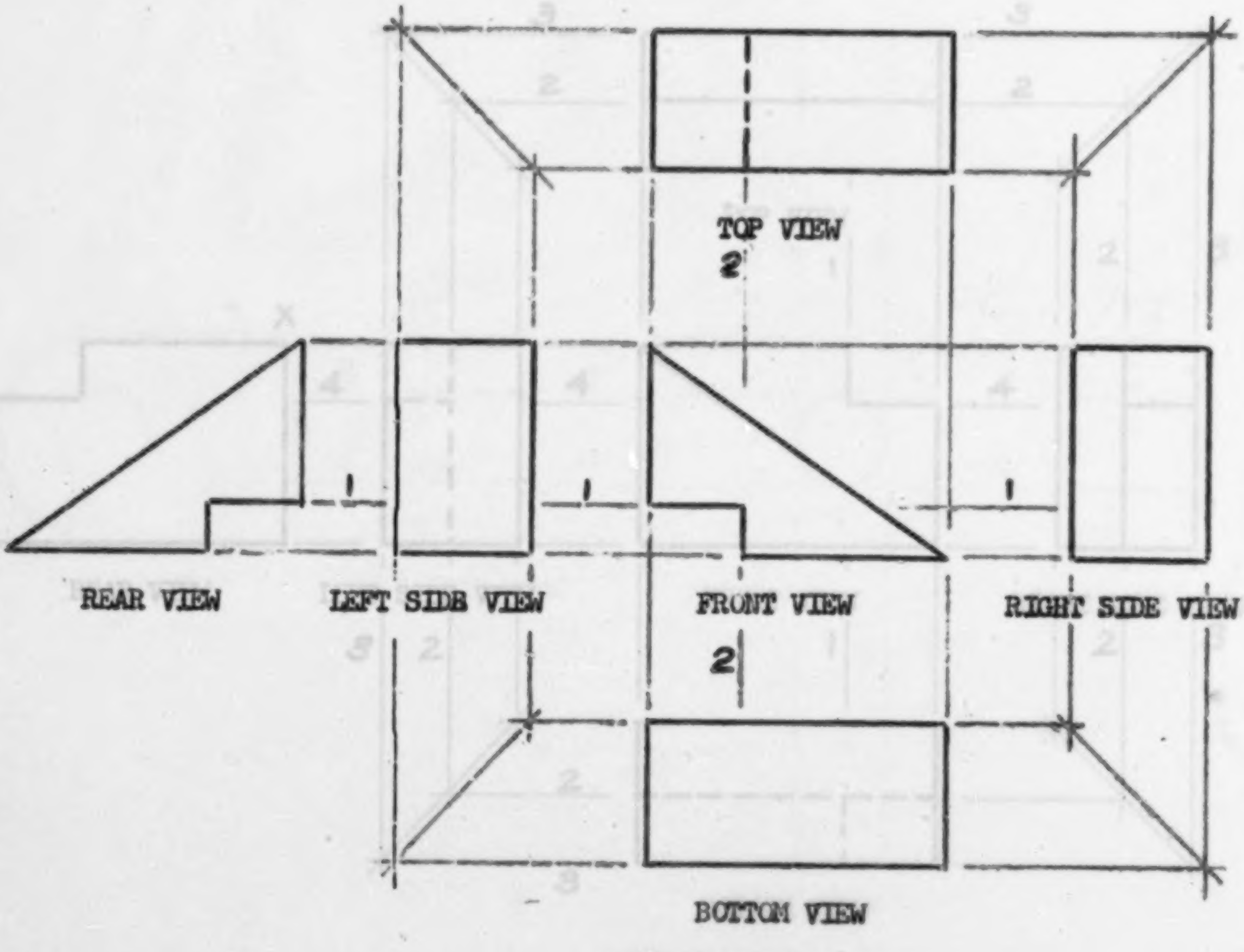
PICTORIAL DRAWING


TOP VIEW
1
2
REAR VIEW
LEFT SIDE VIEW
FRONT VIEW
RIGHT SIDE VIEW
1
2
BOTTOM VIEW

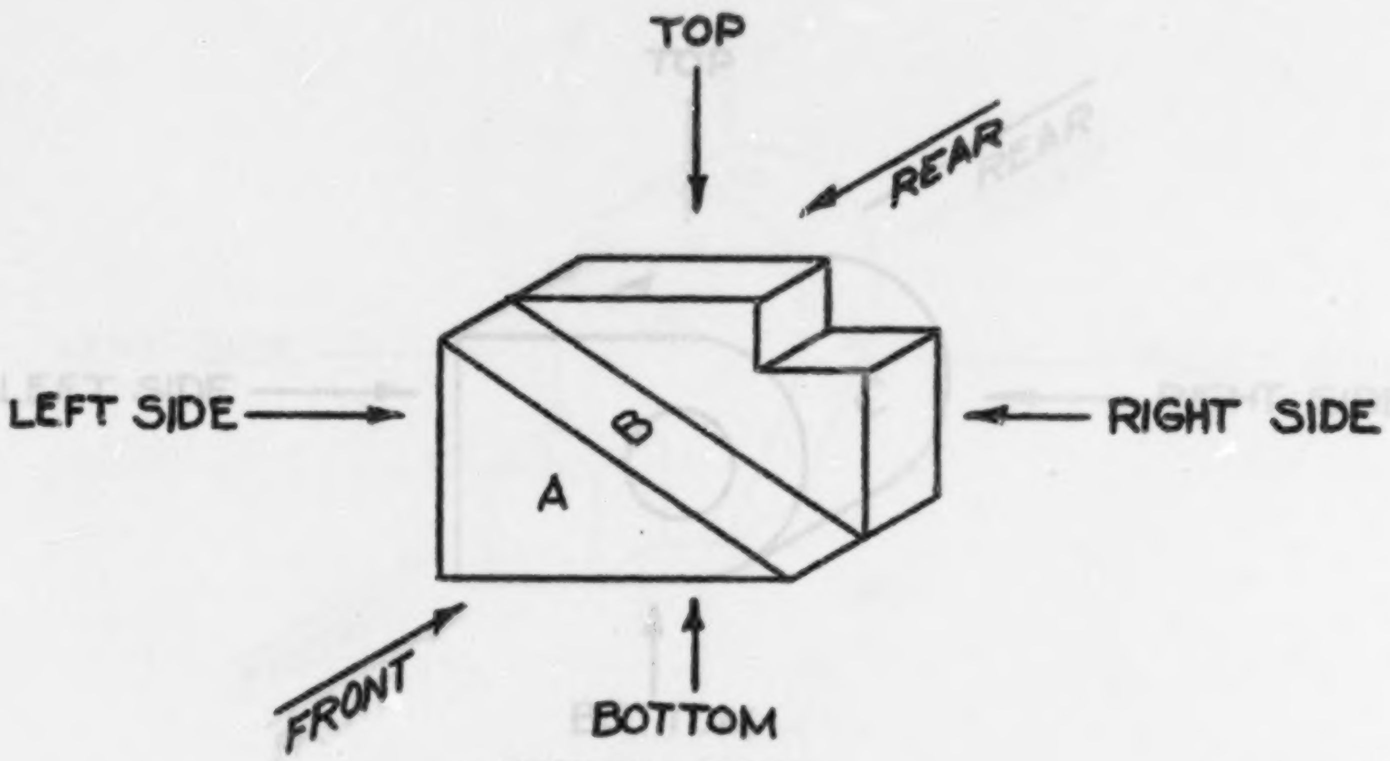
ORTHOGRAPHIC DRAWING


TOP
REAR
LEFT SIDE
RIGHT SIDE
B
A
FRONT
BOTTOM

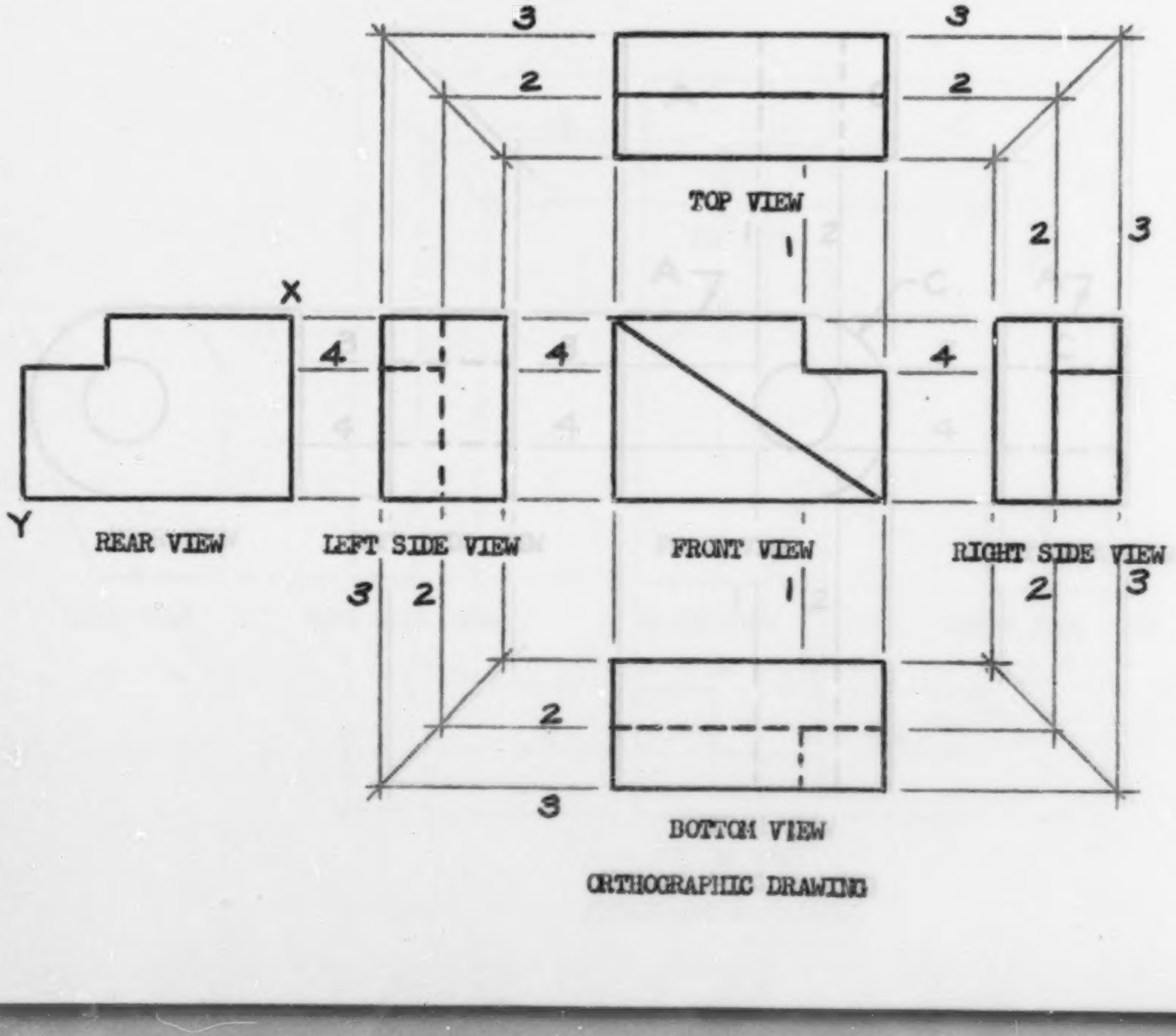
PICTORIAL DRAWING


TOP VIEW
2
1
1
1
REAR VIEW
LEFT SIDE VIEW
FRONT VIEW
RIGHT SIDE VIEW
2
BOTTOM VIEW

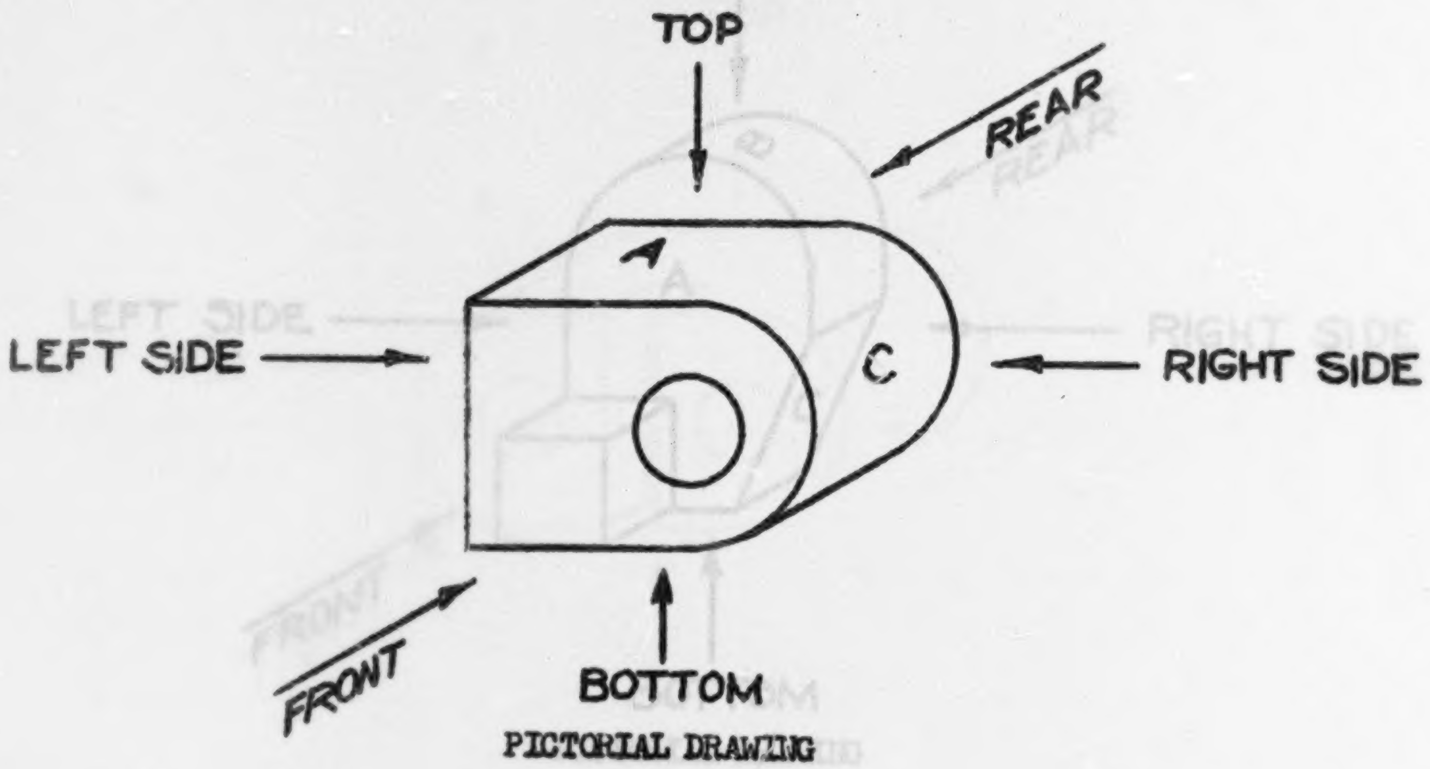
ORTHOGRAPHIC DRAWING


TOP
REAR
LEFT SIDE
RIGHT SIDE
B
A
FRONT
BOTTOM

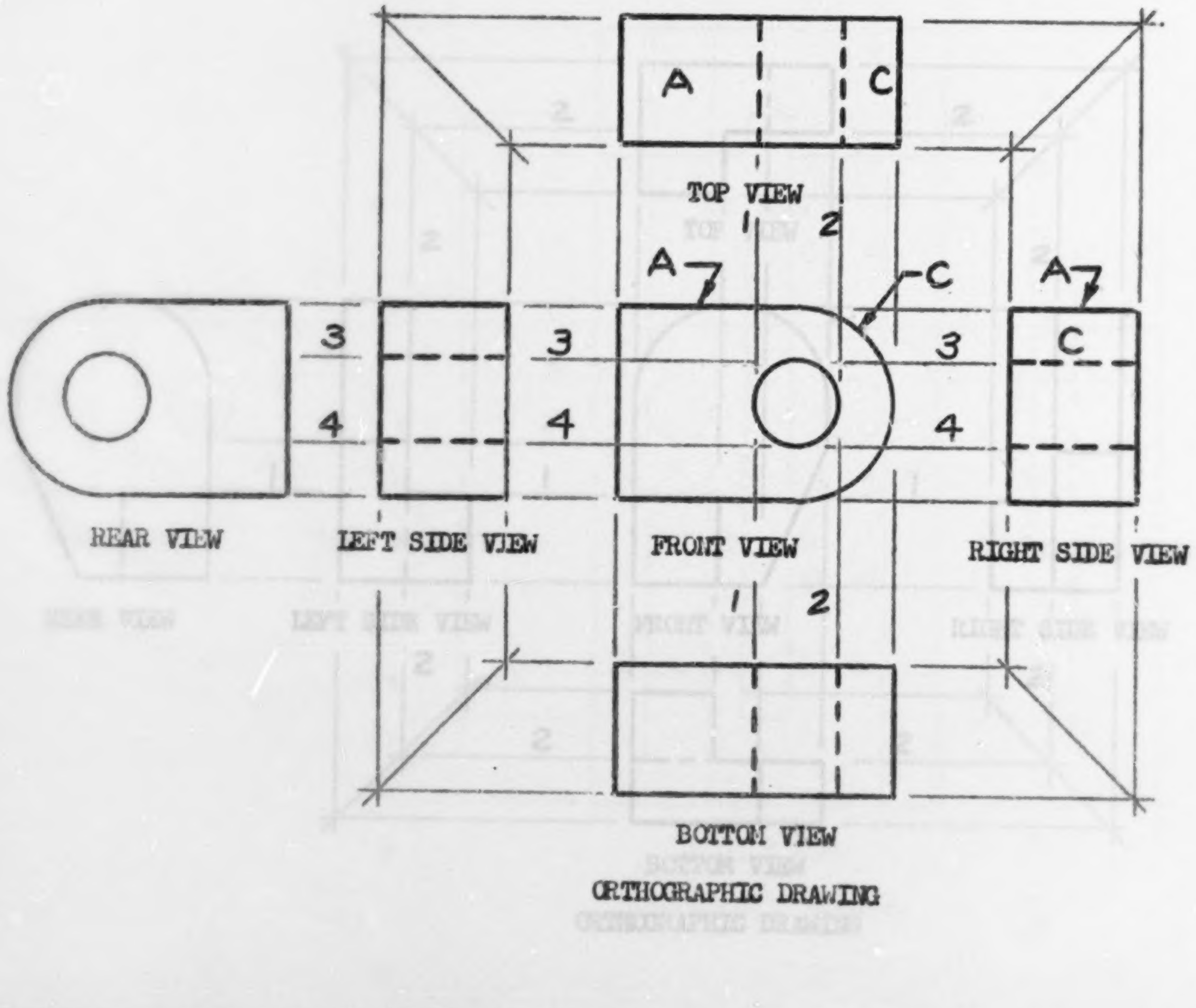
PICTORIAL DRAWING


3
3
2
2
TOP VIEW
1
2
3
X
4
4
4
Y
REAR VIEW
LEFT SIDE VIEW
FRONT VIEW
RIGHT SIDE VIEW
3
2
1
2
3
2
3
BOTTOM VIEW

ORTHOGRAPHIC DRAWING


TOP
REAR
A
LEFT SIDE
C
RIGHT SIDE
FRONT
BOTTOM

PICTORIAL DRAWING

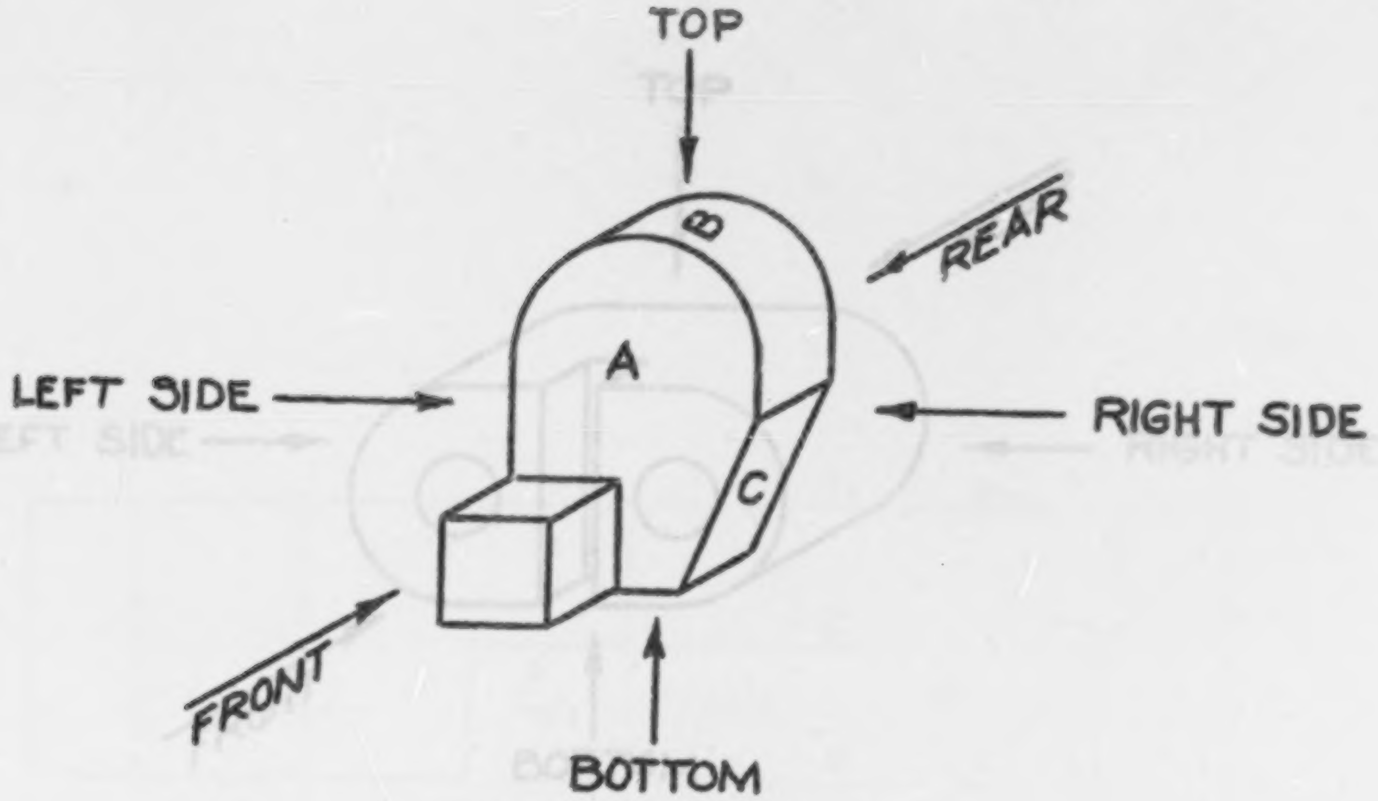

A
C
1
2
A
C
A
C
3
4
3
4
3
4
1
2

TOP VIEW

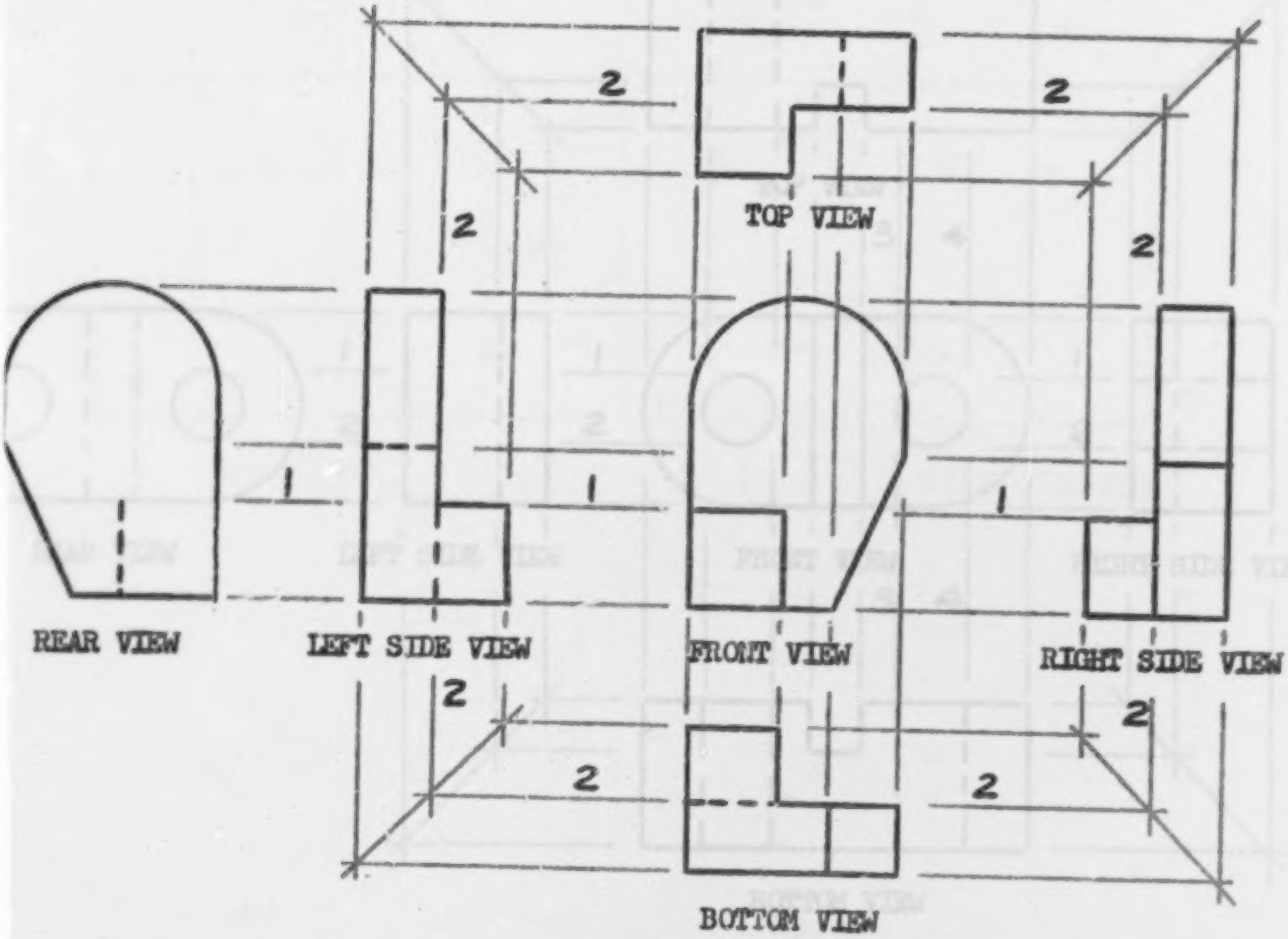
REAR VIEW LEFT SIDE VIEW FRONT VIEW RIGHT SIDE VIEW

BOTTOM VIEW

ORTHOGRAPHIC DRAWING


TOP
B
REAR
A
LEFT SIDE
RIGHT SIDE
C
FRONT
BOTTOM

PICTORIAL DRAWING


2
2
2
2
1
1
1
2
2
2
2

TOP VIEW

REAR VIEW

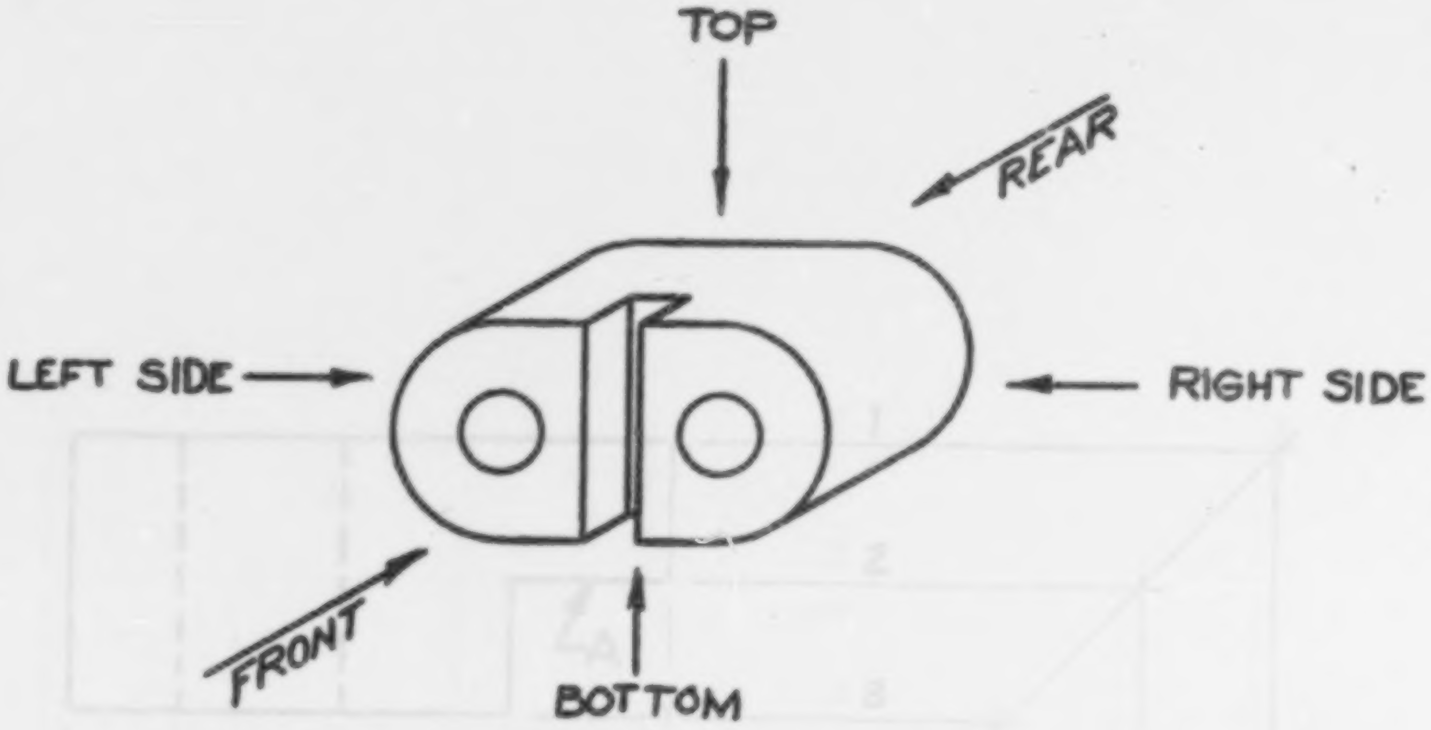
LEFT SIDE VIEW

FRONT VIEW

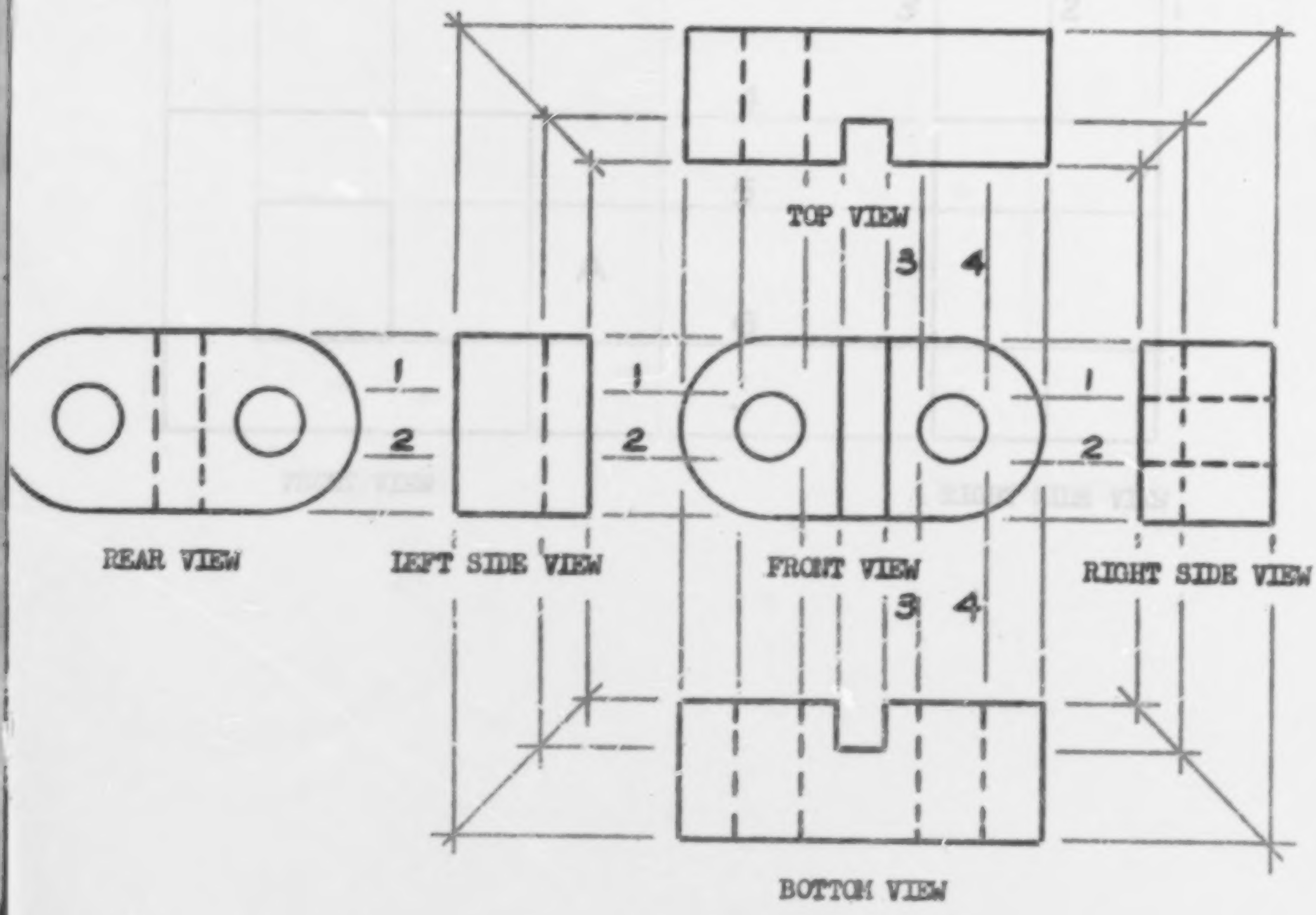
RIGHT SIDE VIEW

BOTTOM VIEW

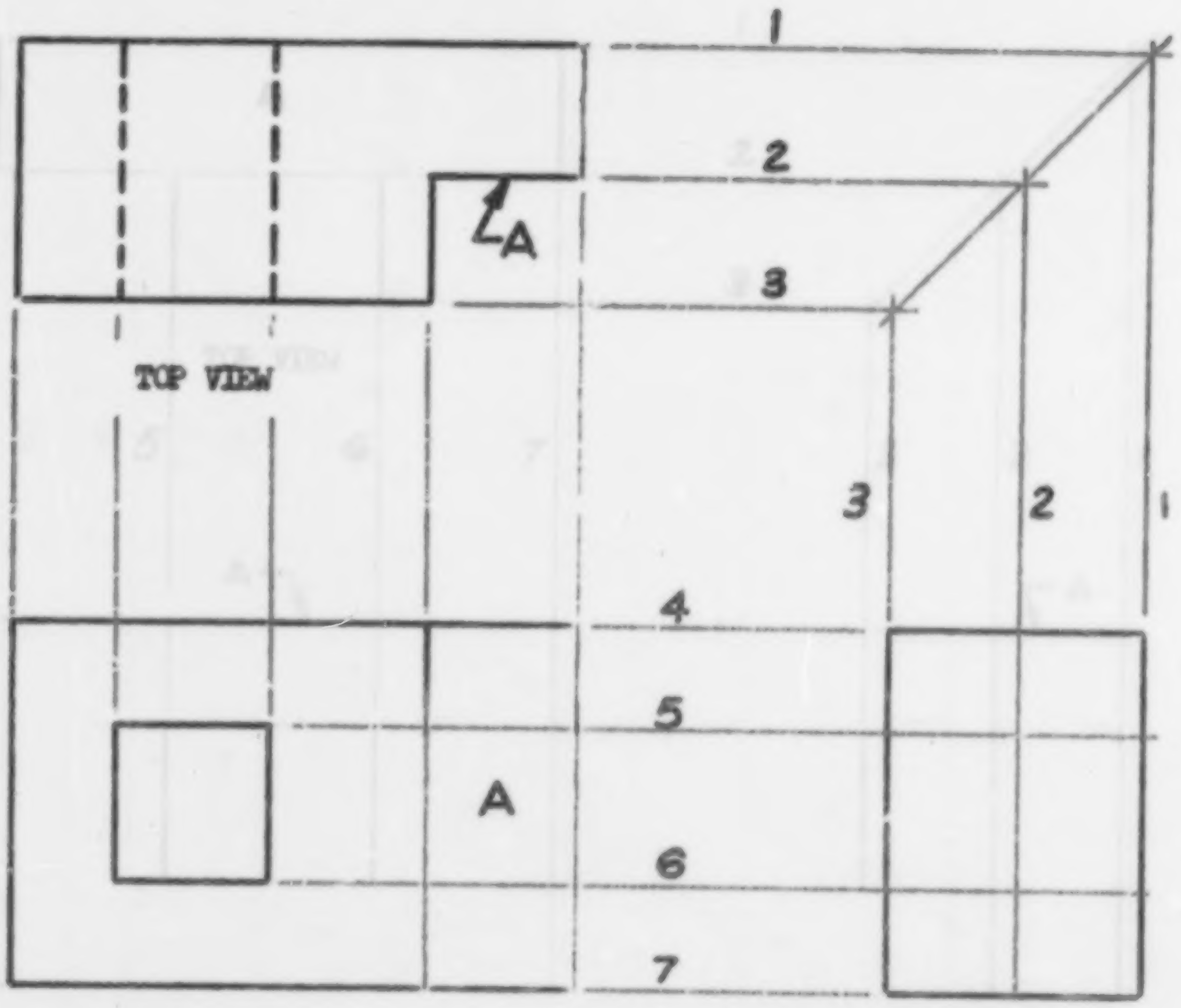
ORTHOGRAPHIC DRAWING

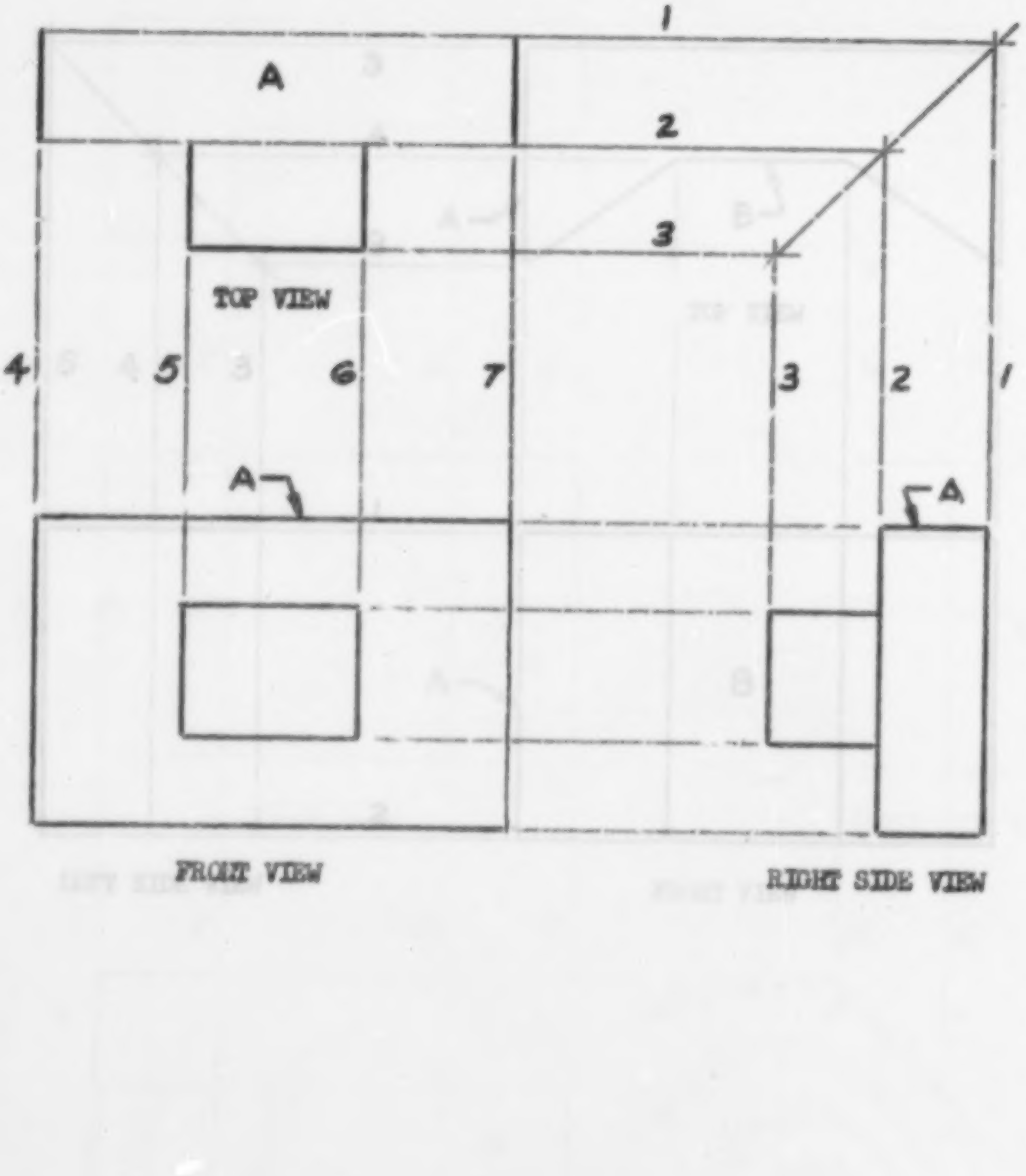

TOP
REAR
LEFT SIDE
RIGHT SIDE
FRONT
BOTTOM

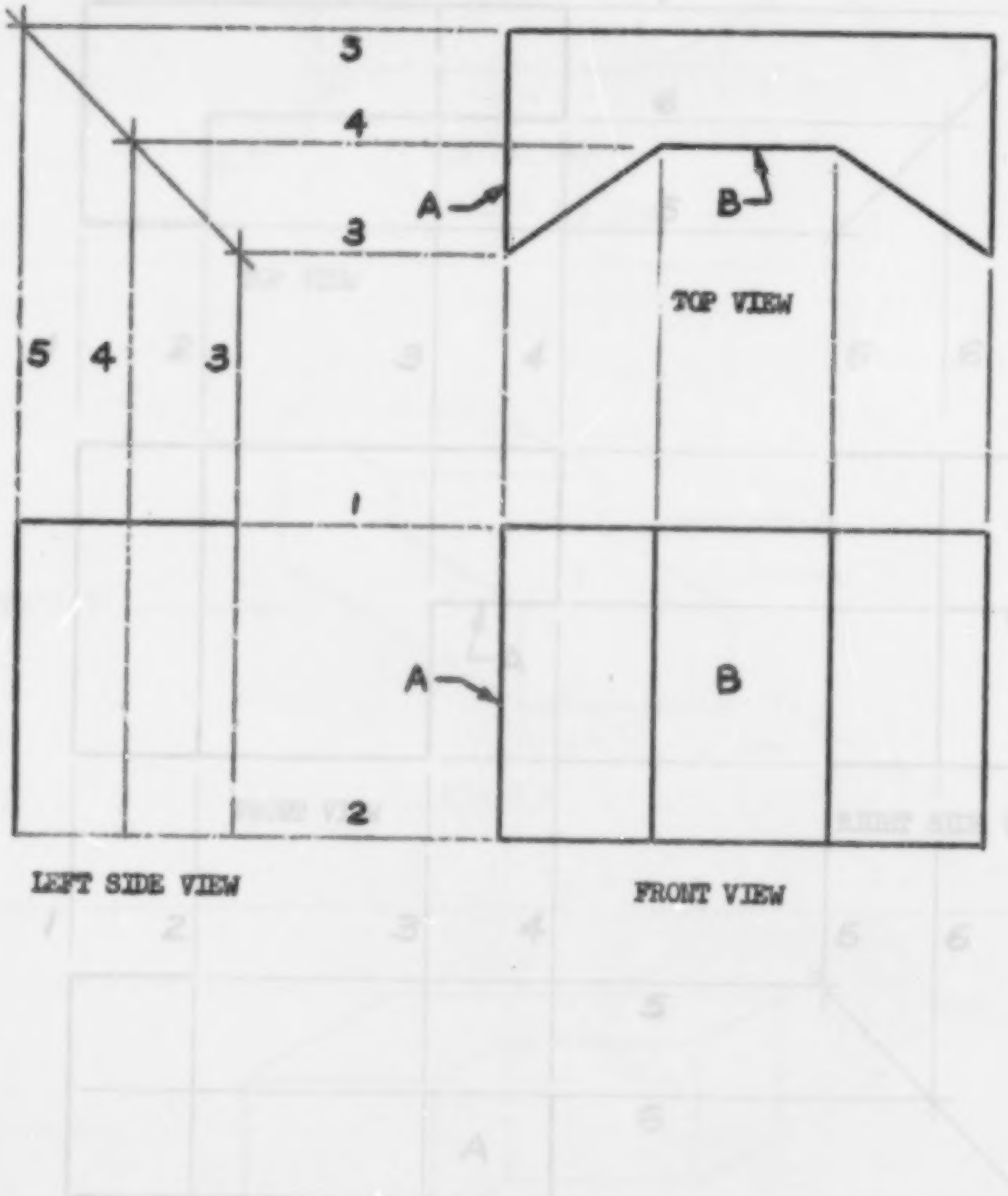
PICTORIAL DRAWING

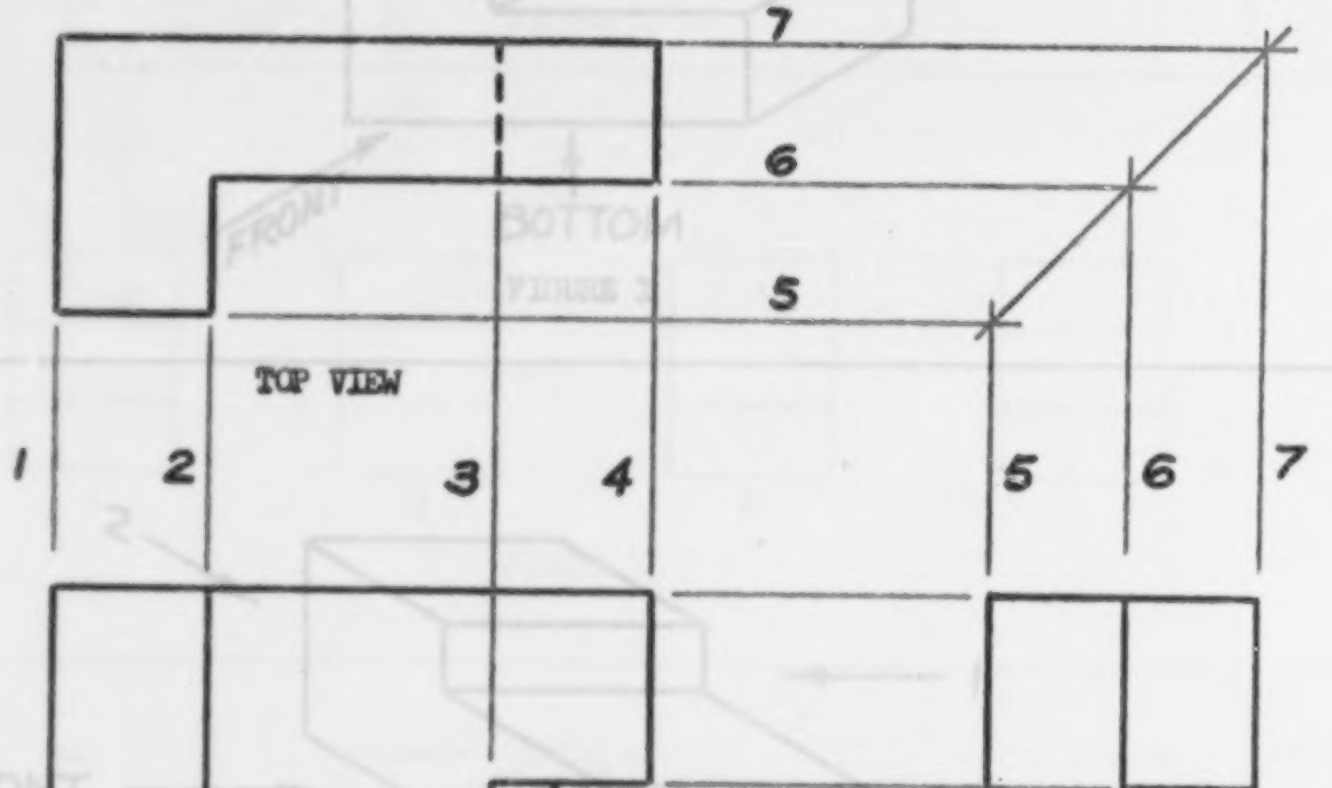

TOP VIEW
3
4
1
2
1
2
1
2
REAR VIEW
LEFT SIDE VIEW
FRONT VIEW
RIGHT SIDE VIEW
3
4
BOTTOM VIEW

ORTHOGRAPHIC DRAWING


A
TOP VIEW
A
FRONT VIEW
RIGHT SIDE VIEW


A
TOP VIEW
A
A
FRONT VIEW
RIGHT SIDE VIEW


3
4
A
B
3
TOP VIEW
5
4
3
1
A
B
2
LEFT SIDE VIEW
FRONT VIEW


TOP VIEW
A
A
FRONT VIEW
RIGHT SIDE VIEW
A
BOTTOM VIEW

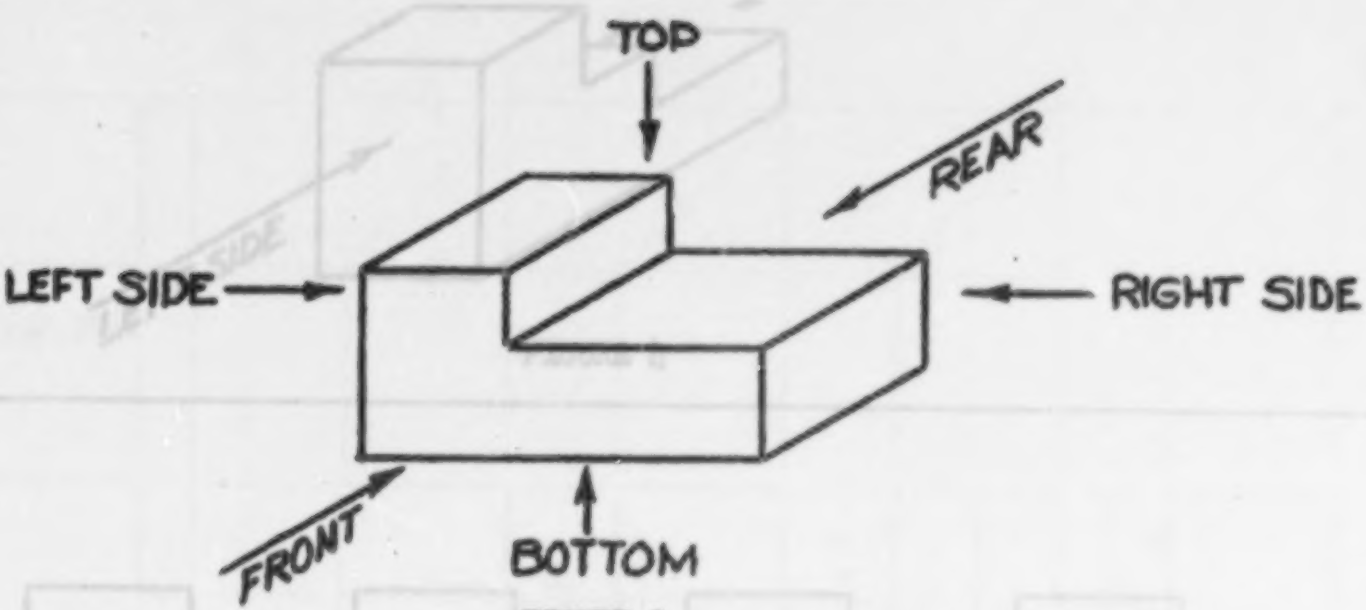

TOP
REAR
LEFT SIDE
RIGHT SIDE
FRONT
BOTTOM

FIGURE 1

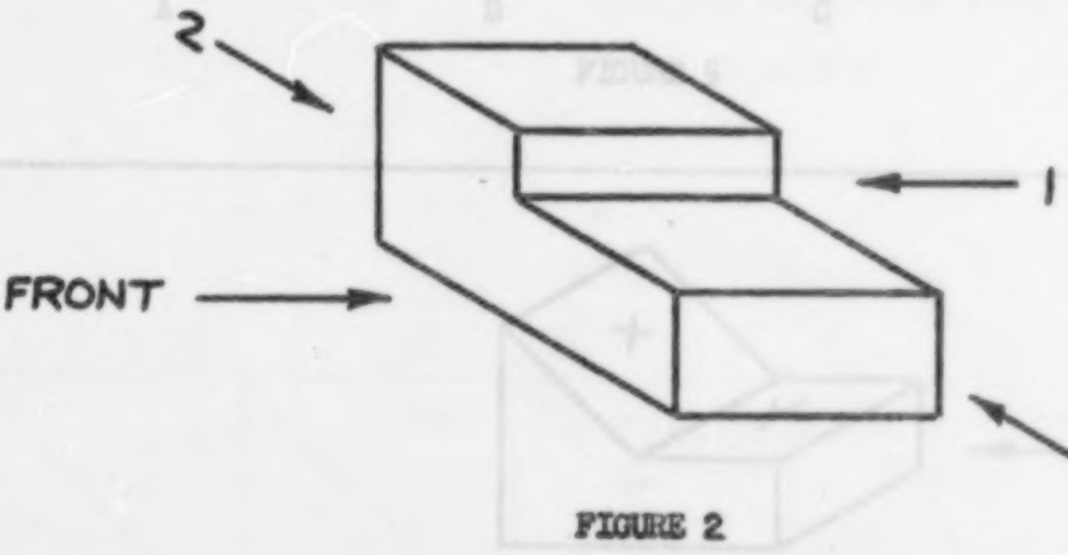


FIGURE 2

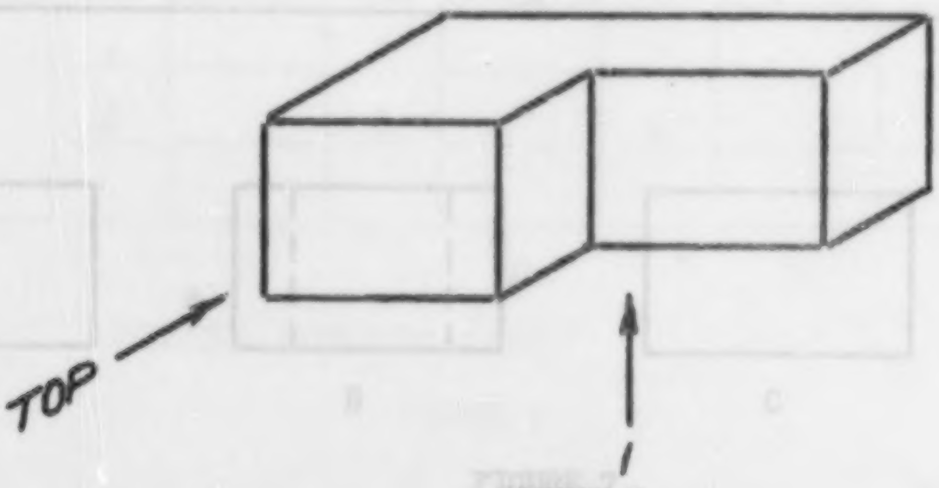


FIGURE 3

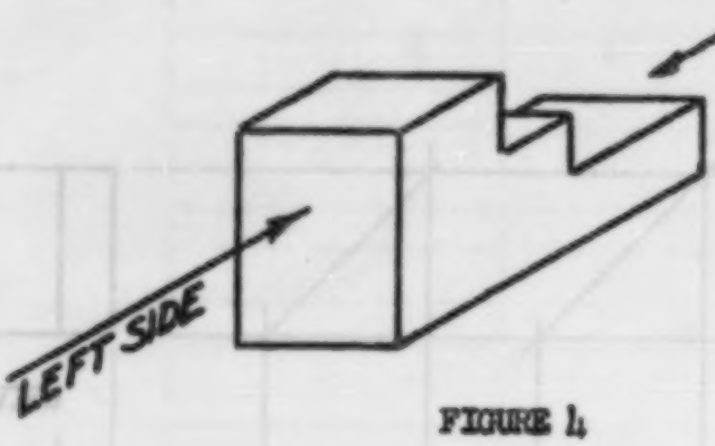
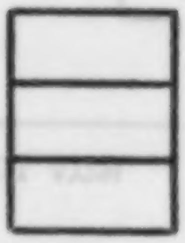
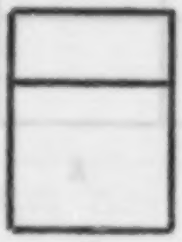
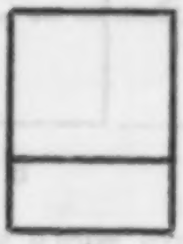


FIGURE 4


A


B


C

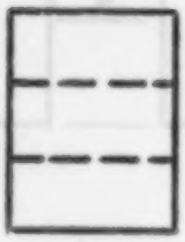

D

FIGURE 5

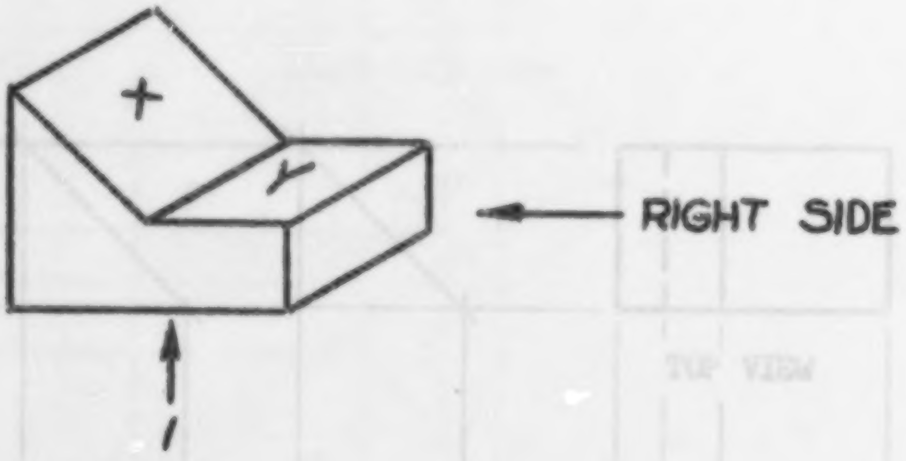
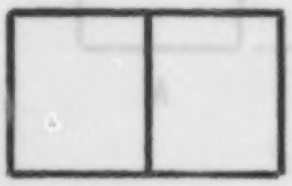
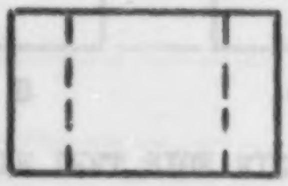
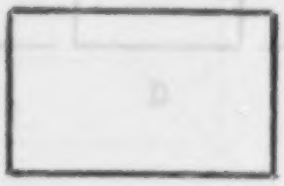

X
Y
RIGHT SIDE
1

FIGURE 6


A


B


C

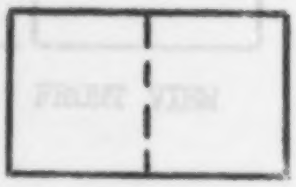
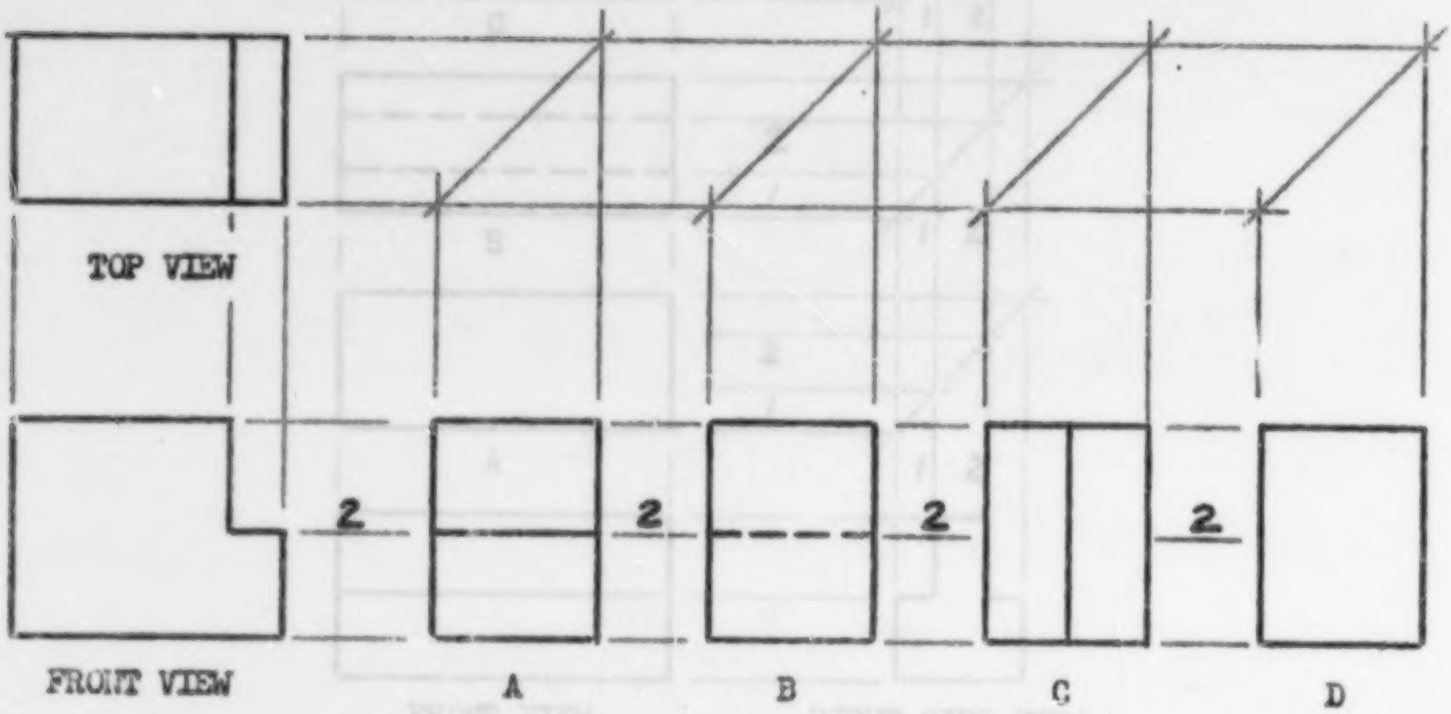
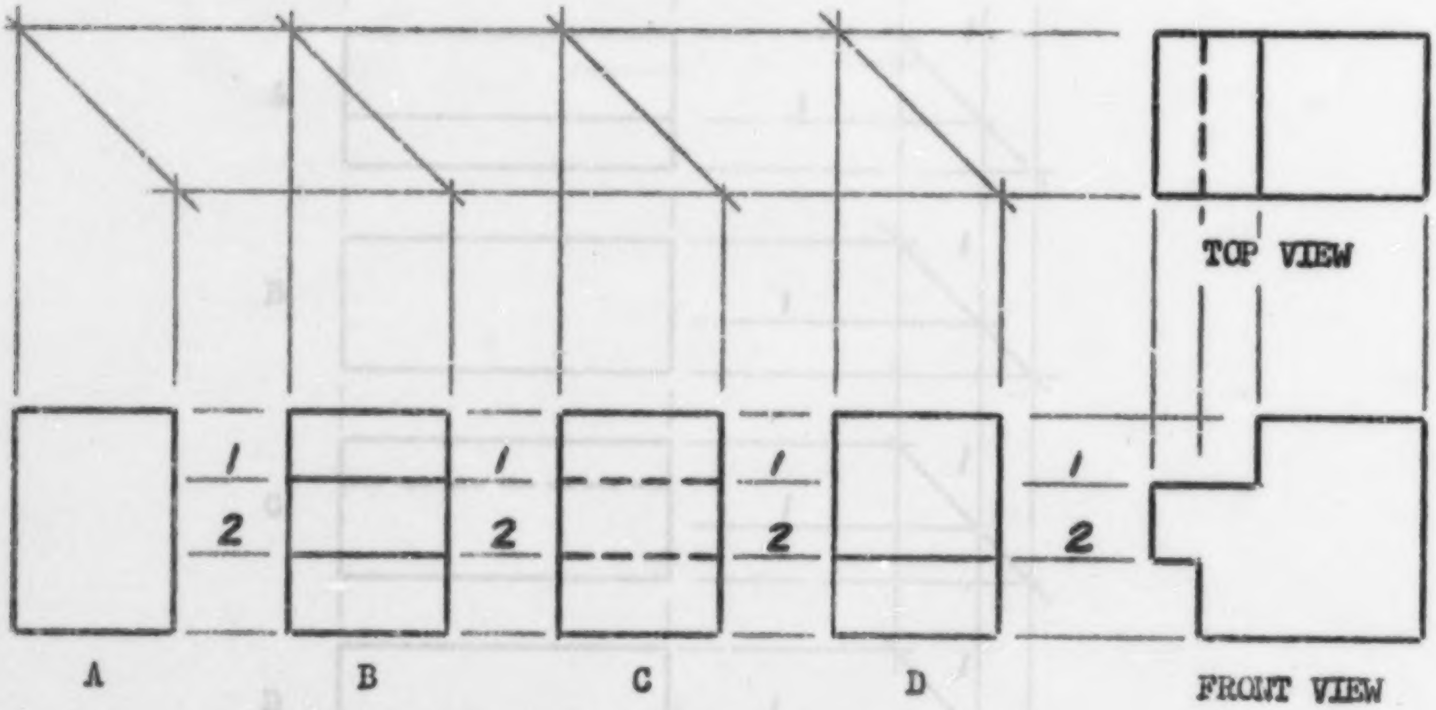

D

FIGURE 7


TOP VIEW
FRONT VIEW
2
2
2
2
A
B
C
D

POSSIBLE RIGHT SIDE VIEWS

FIGURE 8


TOP VIEW
1
2
1
2
1
2
1
2
A
B
C
D
FRONT VIEW

POSSIBLE LEFT SIDE VIEWS

FIGURE 9

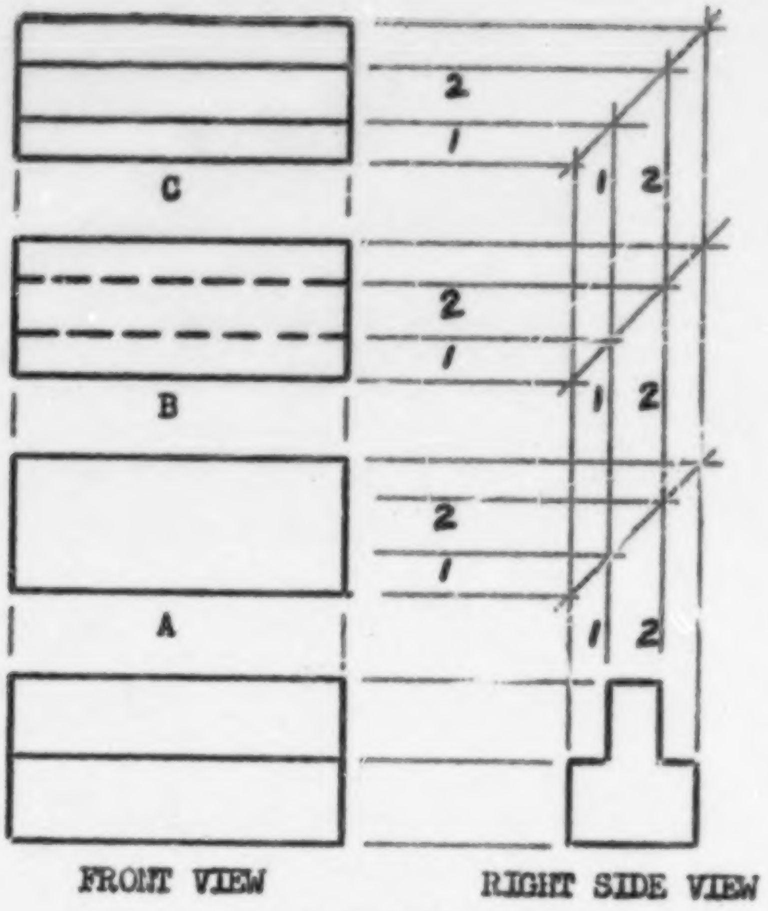

2
1
1
2
C
2
1
1
2
B
2
1
A
1
2
FRONT VIEW
RIGHT SIDE VIEW

FIGURE 10

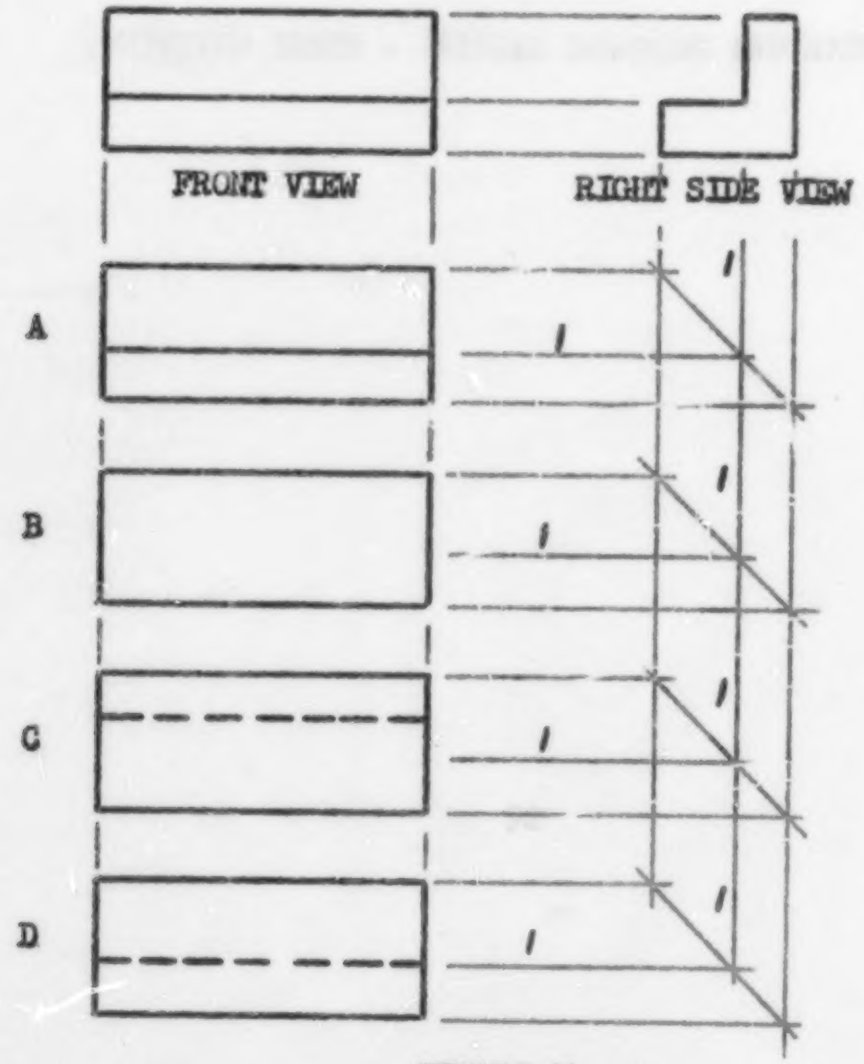

FRONT VIEW
RIGHT SIDE VIEW
A
1
1
B
1
1
C
1
1
D
1
1

FIGURE 11

APPENDIX C

CRITERION TESTS - INITIAL LEARNING AND RETENTION

Name________________________________ Research Group Number_______

ANSWER SHEET: Parts 1A - 1B

PART 1A

________ 1

________ 2

________ 3

________ 4

________ 5

________ 6

________ 7

PART 1B

________ View 1

________ View 2

________ View 3

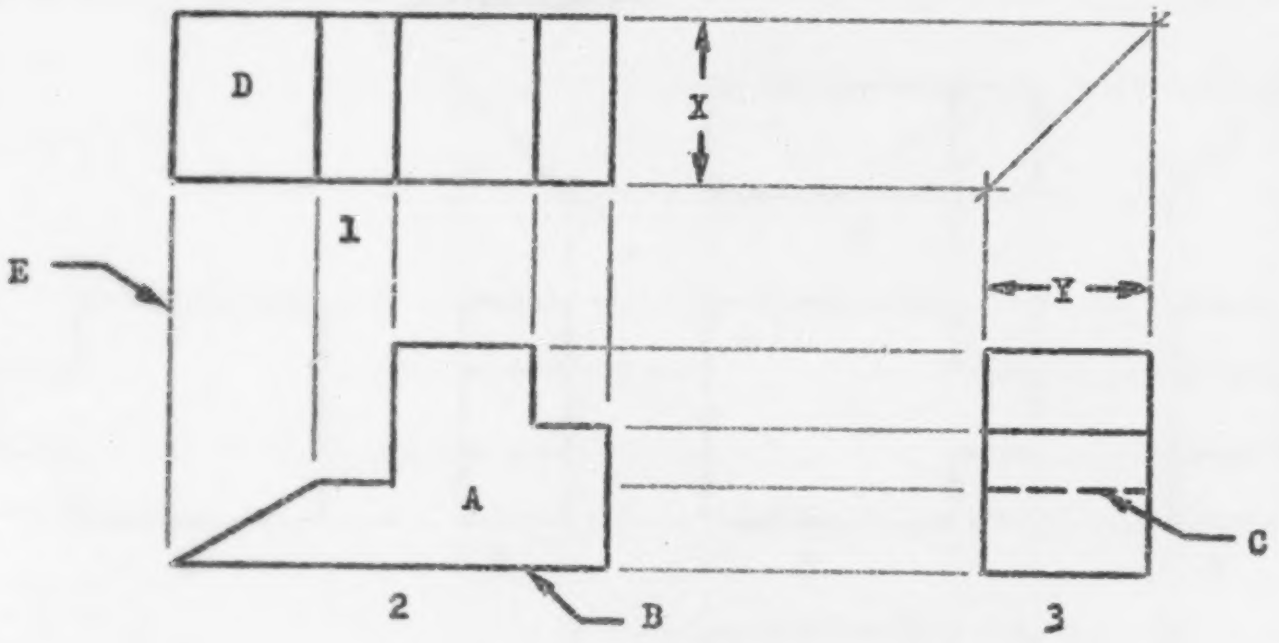
________ View 4

________ View 5

________ View 6

PART 1A

Directions. For each of the following questions based on the drawing below you are to select the answer you believe to be correct. Place the letter representing your answer on the Answer Sheet.



1. Surface "A" in the drawing above is (a, an) (A) isometric surface, (B) oblique surface, (C) inclined surface, (D) normal surface, (E) warped surface, or (F) none of these.

2. Line "B" is (a, an) (A) object line, (B) extension line, (C) section line, (D) hidden line, (E) cutting plane line. or (F) none of these.

3. Line "C" is (a, an) (A) phantom line, (B) object line, (C) extension line, (D) hidden line, (E) cutting plane line, or (F) none of these.

4. Surface "D" is (a, an) (A) auxiliary surface, (B) normal surface, (C) oblique surface, (D) isometric surface, (E) warped surface, or (F) none of these.

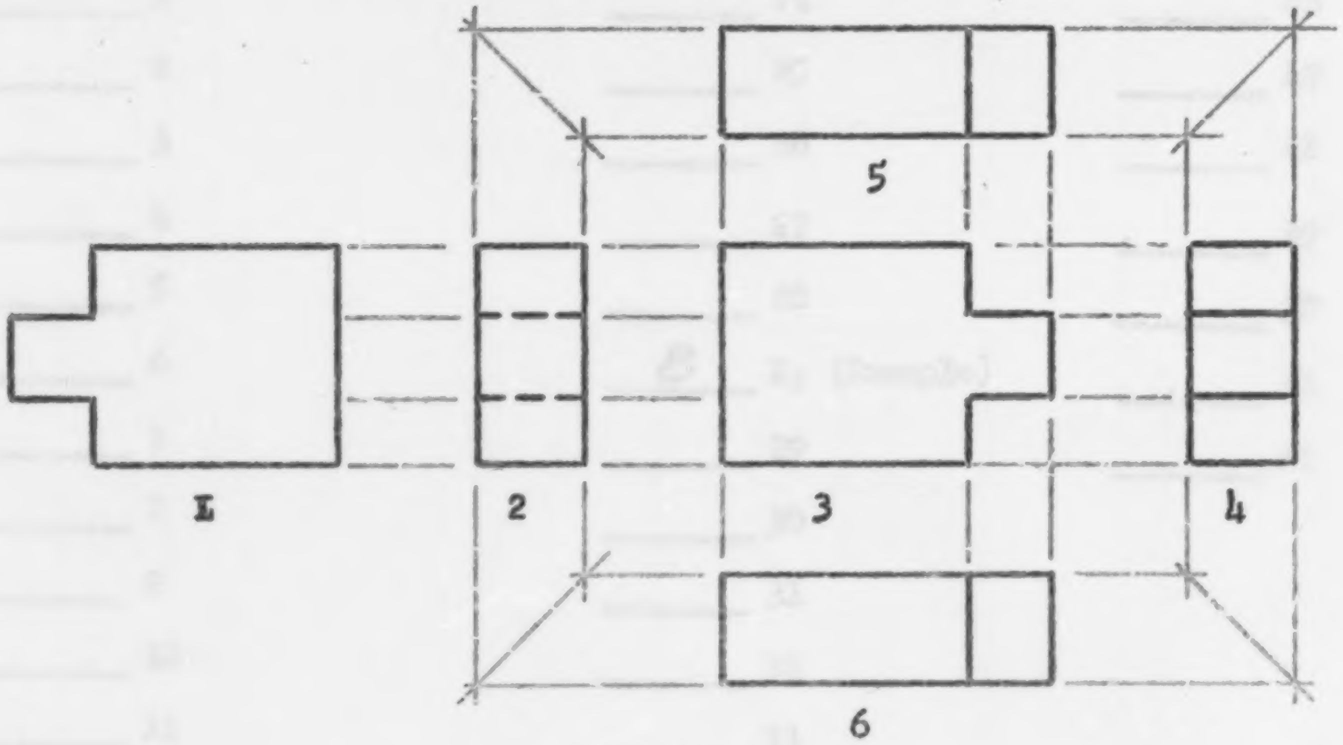
5. Line "E" is (a,an) (A) object line, (B) hidden line, (C) projection line, (D) section line, (E) cutting plane line, or (F) none of these.

6. The type of drawing illustrated by the three views is (A) isometric, (B) oblique cavalier, (C) dimetric projection, (D) orthographic projection (E) oblique cabinet, or (F) none of these.

7. Dimension "X" in view "1" (A) rarely, (B) usually, (C) may, (D) always, (E) never, equals dimension "Y" in view 3, or (F) none of these answers is correct.

PART IB

Directions. A six-view drawing is illustrated below. Each of the six views has a correct technical name. In the right hand column under the drawing is a list of possible names of the views. Six of these are correct. Match the names of the views in the right hand column with the views illustrated in the drawing. Select the letter representing your choice and place it in the appropriate blank on the Answer Sheet.



View 1

View 2

View 3

View 4

View 5

View 6

A. Oblique view

B. Top view

C. Isometric view

D. Right Side View

E. Front view

F. Dimetric view

G. Bottom view

H. Rear view

I. Trimetric view

J. Left side view

Name_______________________________ Research Group Number_____________

ANSWER SHEET

Please place your answers on this sheet. Do not mark in the test booklet.

__C__ X_1 (Example)
_______ 1
_______ 2
_______ 3
_______ 4
_______ 5
_______ 6
_______ 7
_______ 8
_______ 9
_______ 10
_______ 11
_______ 12
_______ 13
_______ 14
_______ 15
_______ 16
_______ 17
_______ 18
_______ 19
_______ 20
_______ 21
_______ 22

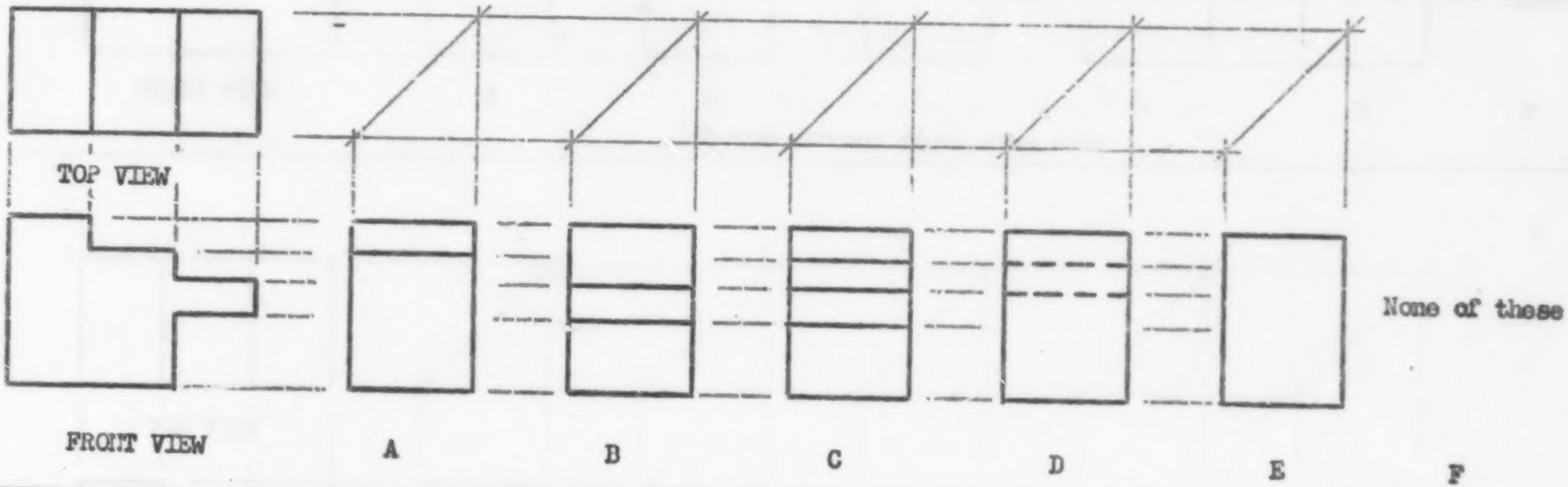
_______ 23
_______ 24
_______ 25
_______ 26
_______ 27
_______ 28
__B__ X_2 (Example)
_______ 29
_______ 30
_______ 31
_______ 32
_______ 33
_______ 34
_______ 35
_______ 36
_______ 37
_______ 38
_______ 39
_______ 40
_______ 41
_______ 42
_______ 43
_______ 44

_______ 45
_______ 46
_______ 47
_______ 48
_______ 49
_______ 50
_______ 51
_______ 52

Directions: Problems 1-28

The principle of orthographic projection enables one to "solve," or to draw a third view of an object if two views are given on which to base the solution. For example, if one is given a front and top view of an object the right side view can be solved by projection. In the problems to follow you will be given two views of an object, and five possible solutions for the third view. Study the two views of the object and the projection lines (red) extending from the completed two-view drawing to each of the five possible solutions. Indicate which one of the five possible third views you believe to be correct by placing the appropriate letter on the Answer Sheet. If none of the given views is correct, choose the letter indicating ("None of these") and place it on the Answer Sheet.

Example



Choose correct right side view

Answer Sheet (Example)

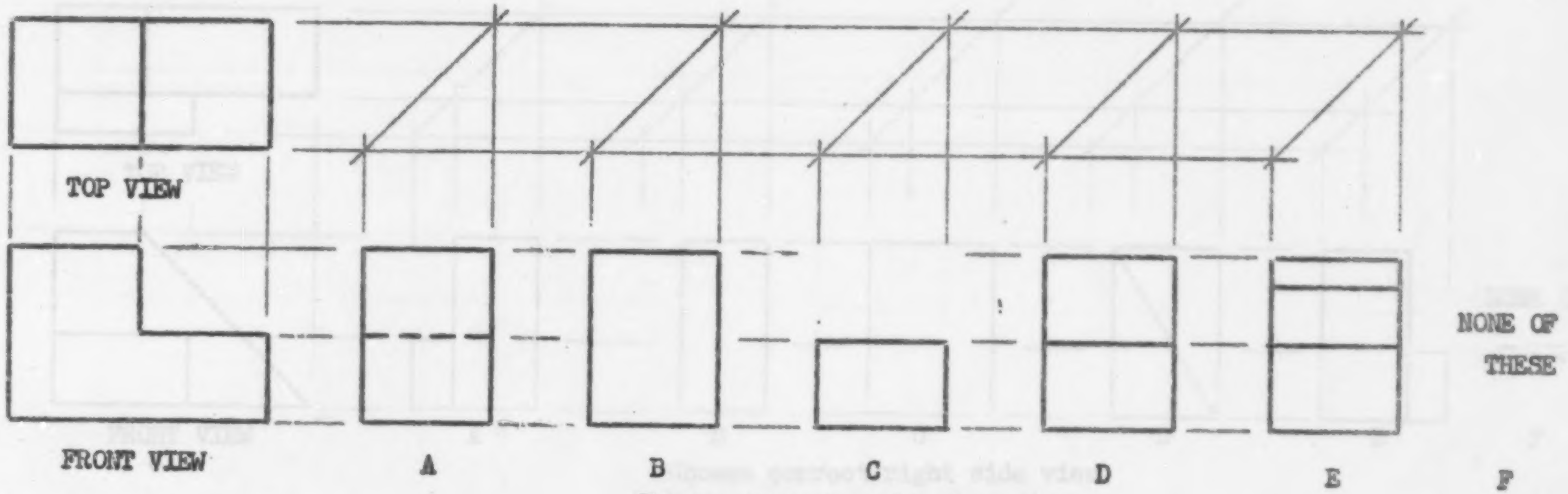
C X1

_______ 1

_______ 2

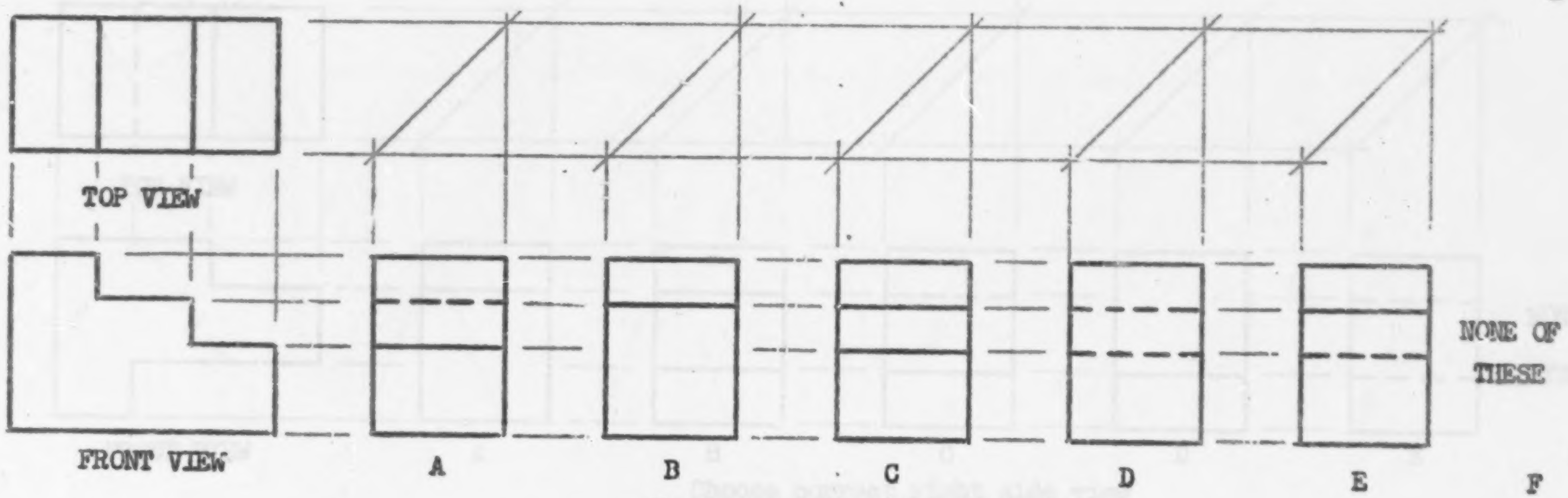
_______ 3

1


TOP VIEW
FRONT VIEW
A
B
C
D
E
NONE OF THESE
F

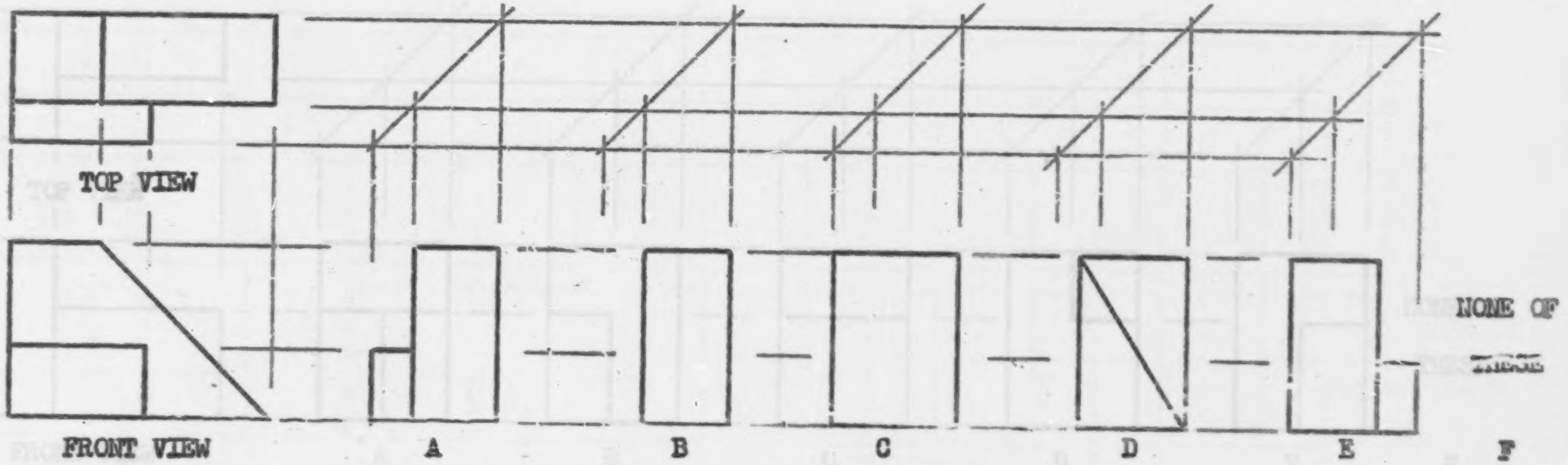
Choose correct right side view

2


TOP VIEW
FRONT VIEW
A
B
C
D
E
NONE OF THESE
F

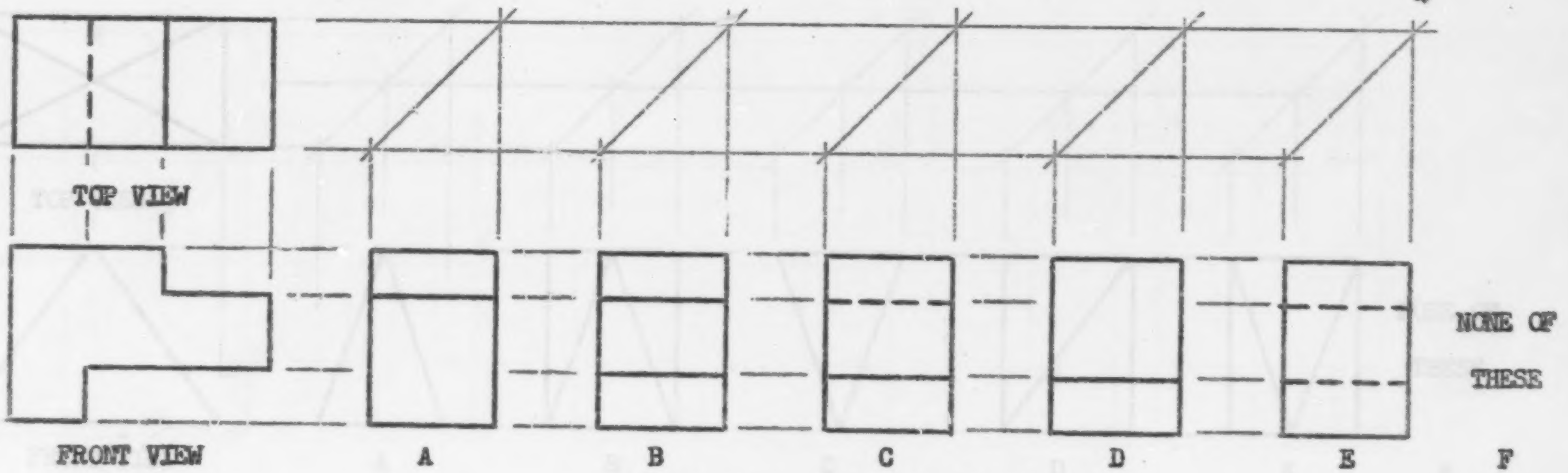
Choose correct right side view

3


TOP VIEW
FRONT VIEW
A
B
C
D
E
NONE OF THESE
F

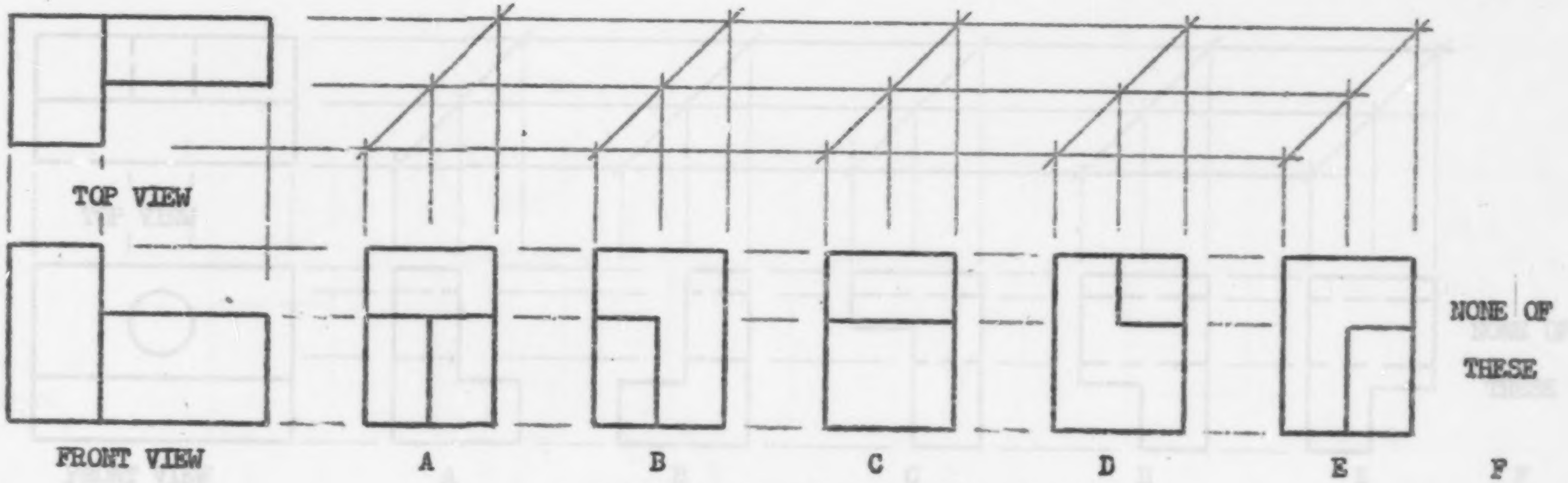
Choose correct right side view

4


TOP VIEW
FRONT VIEW
A
B
C
D
E
NONE OF THESE
F

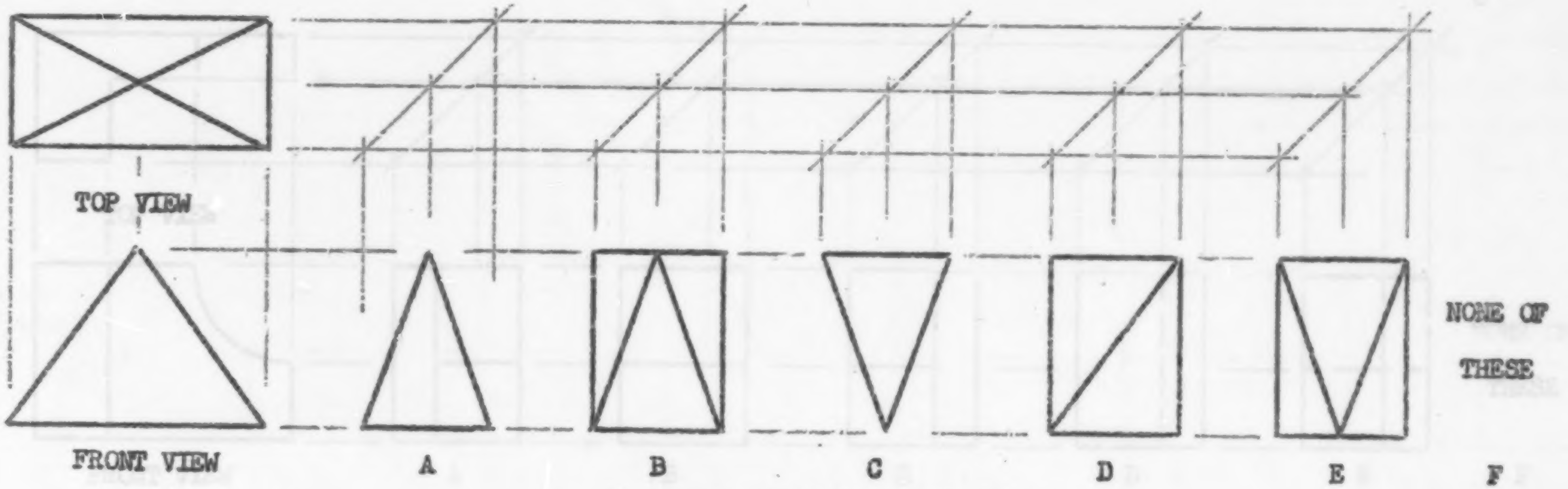
Choose correct right side view

5


TOP VIEW
FRONT VIEW
A
B
C
D
E
NONE OF THESE
F

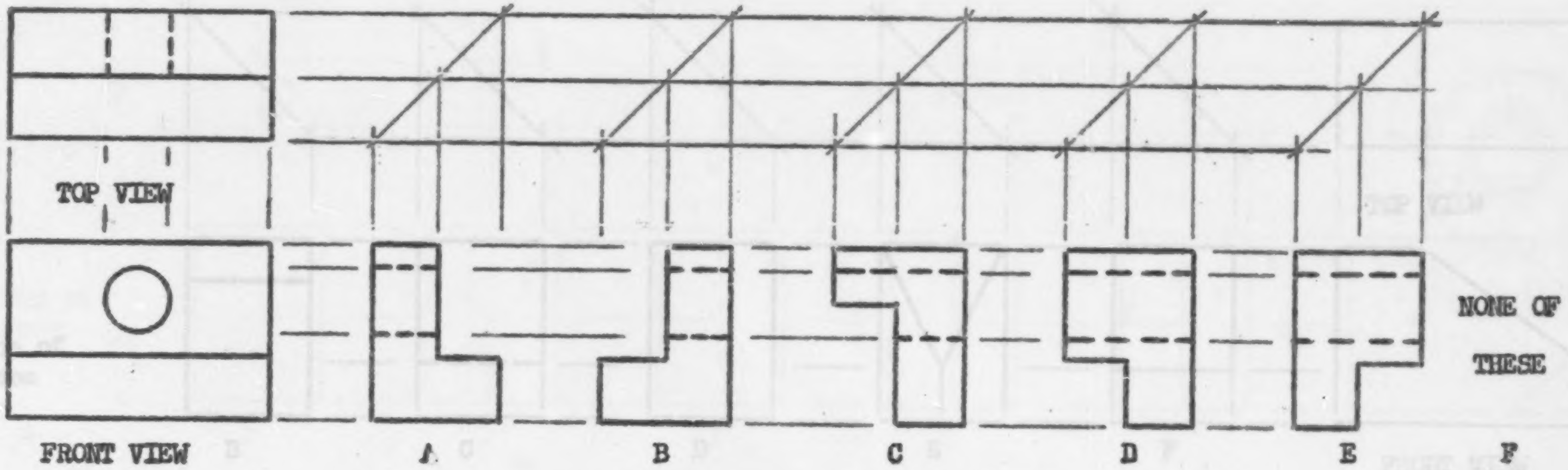
Choose correct right side view

6


TOP VIEW
FRONT VIEW
A
B
C
D
E
NONE OF THESE
F

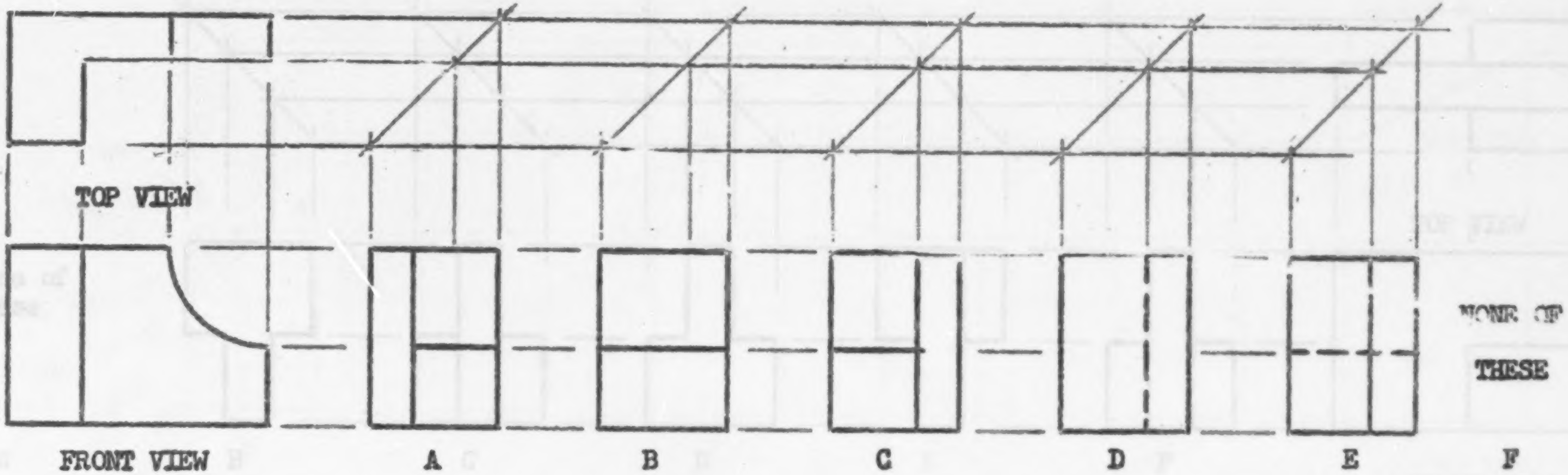
Choose correct right side view

7


TOP VIEW
FRONT VIEW
A
B
C
D
E
NONE OF THESE
F

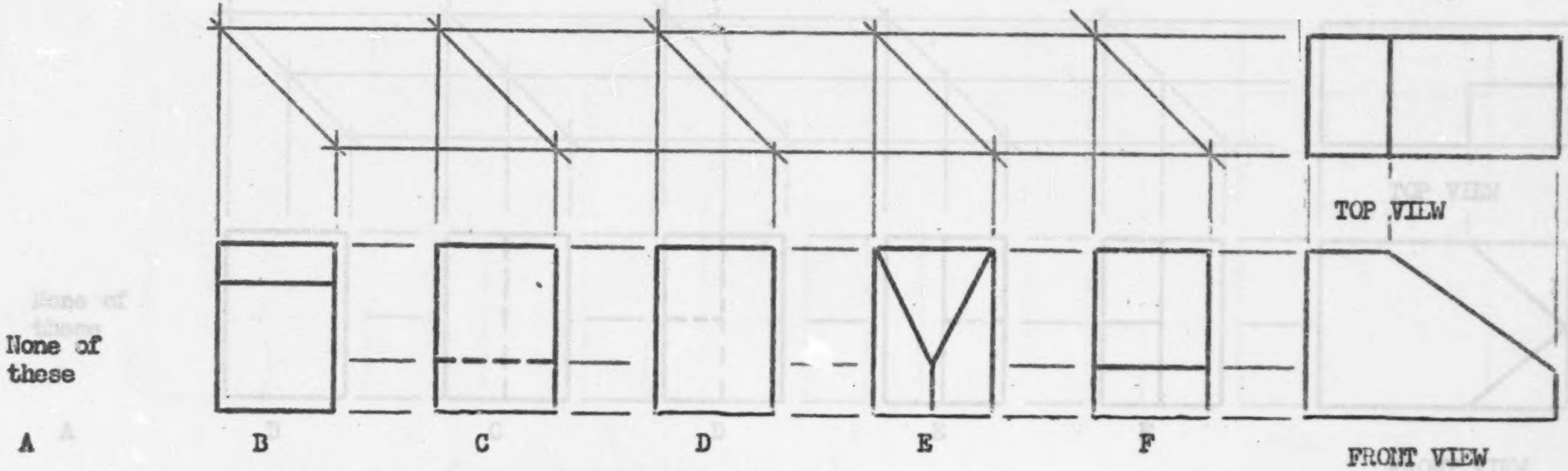
Choose correct right side view

8


TOP VIEW
FRONT VIEW
A
B
C
D
E
NONE OF THESE
F

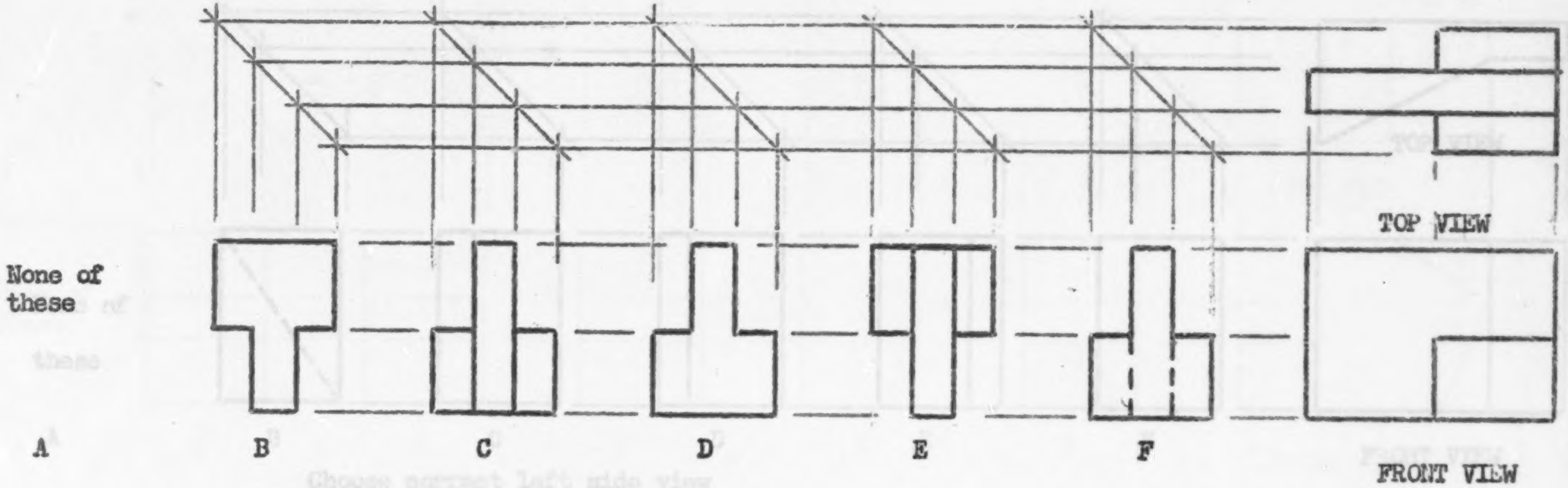
Choose correct right side view

9


TOP VIEW
None of these
A
B
C
D
E
F
FRONT VIEW

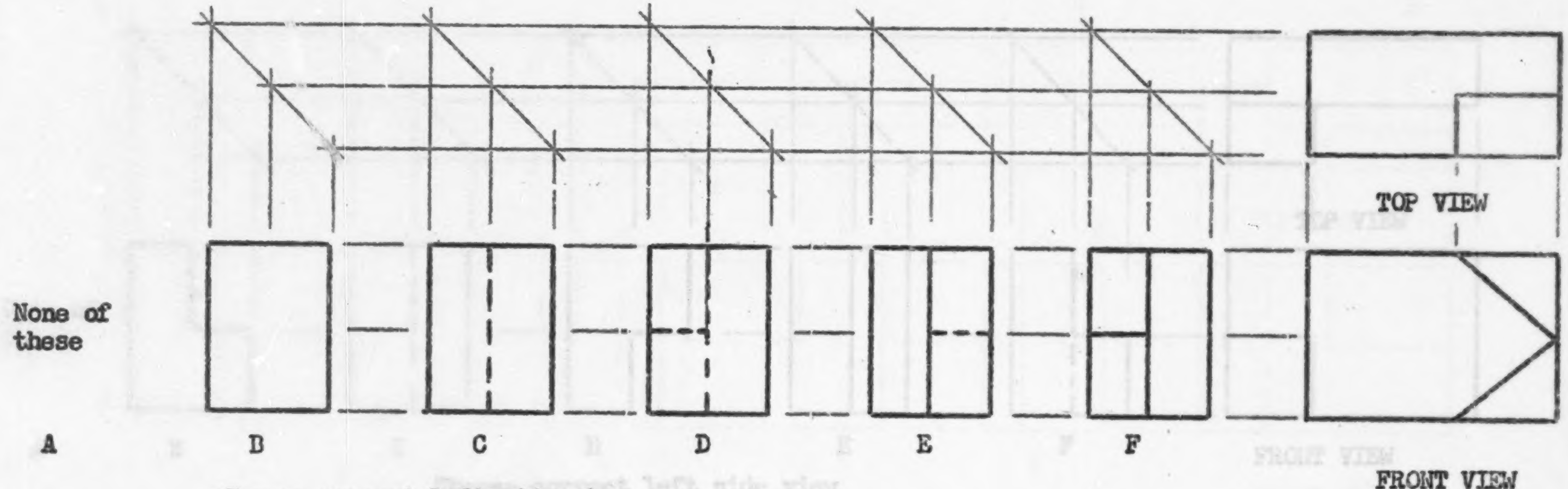
Choose correct left side view

10


TOP VIEW
None of these
A
B
C
D
E
F
FRONT VIEW

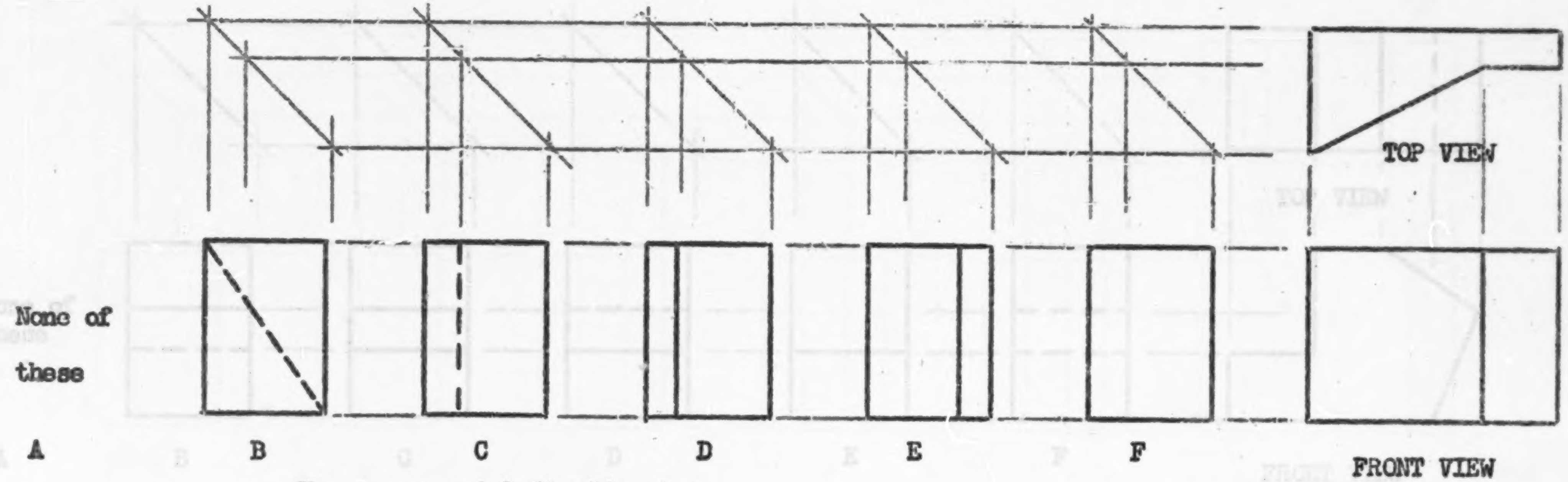
Choose correct left side view

11


None of these
A
B
C
D
E
F
TOP VIEW
FRONT VIEW

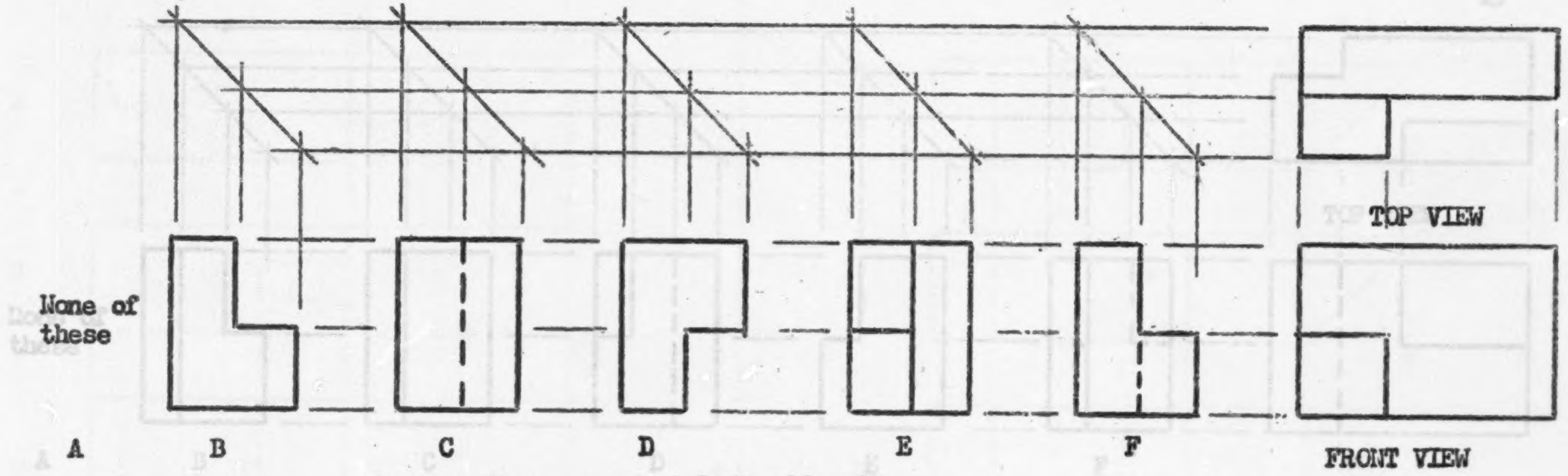
Choose correct left side view

12


None of these
A
B
C
D
E
F
TOP VIEW
FRONT VIEW

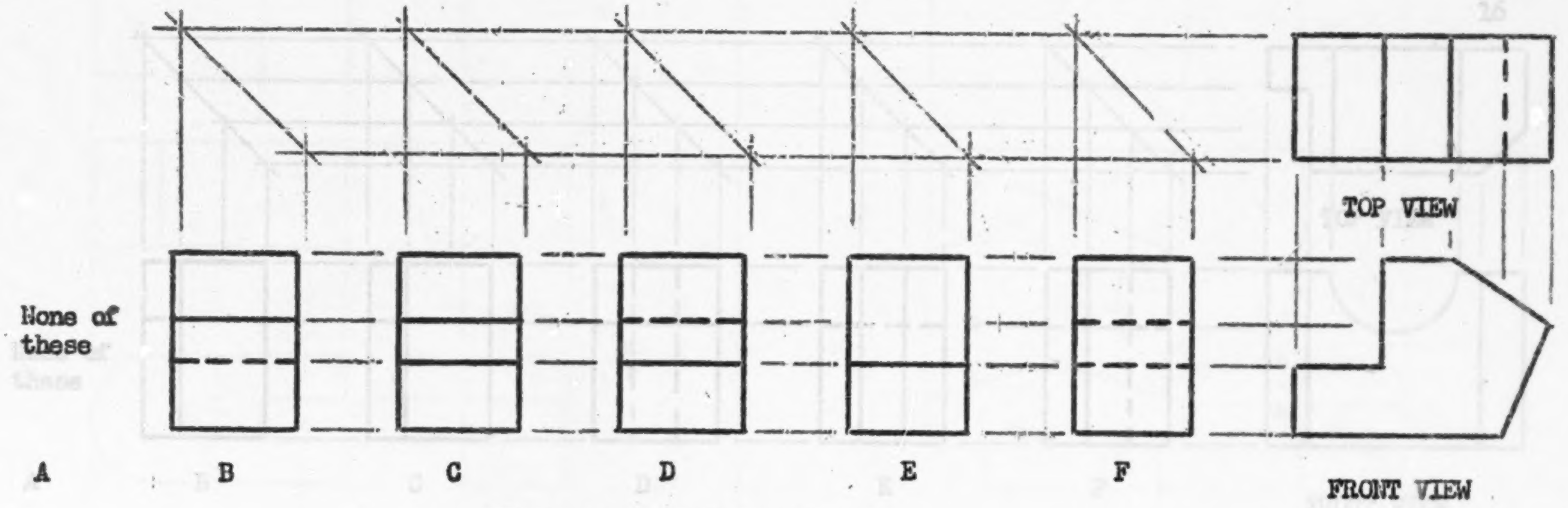
Choose correct left side view

13


None of these
A
B
C
D
E
F
TOP VIEW
FRONT VIEW

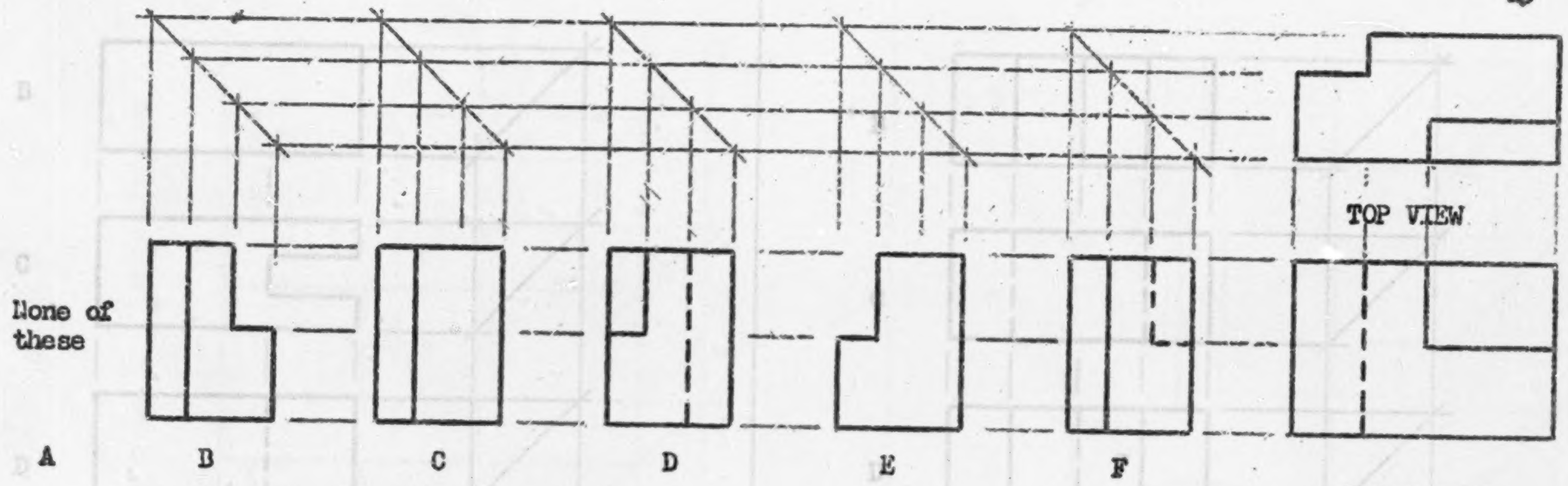
Choose correct left side view

14


None of these
A
B
C
D
E
F
TOP VIEW
FRONT VIEW

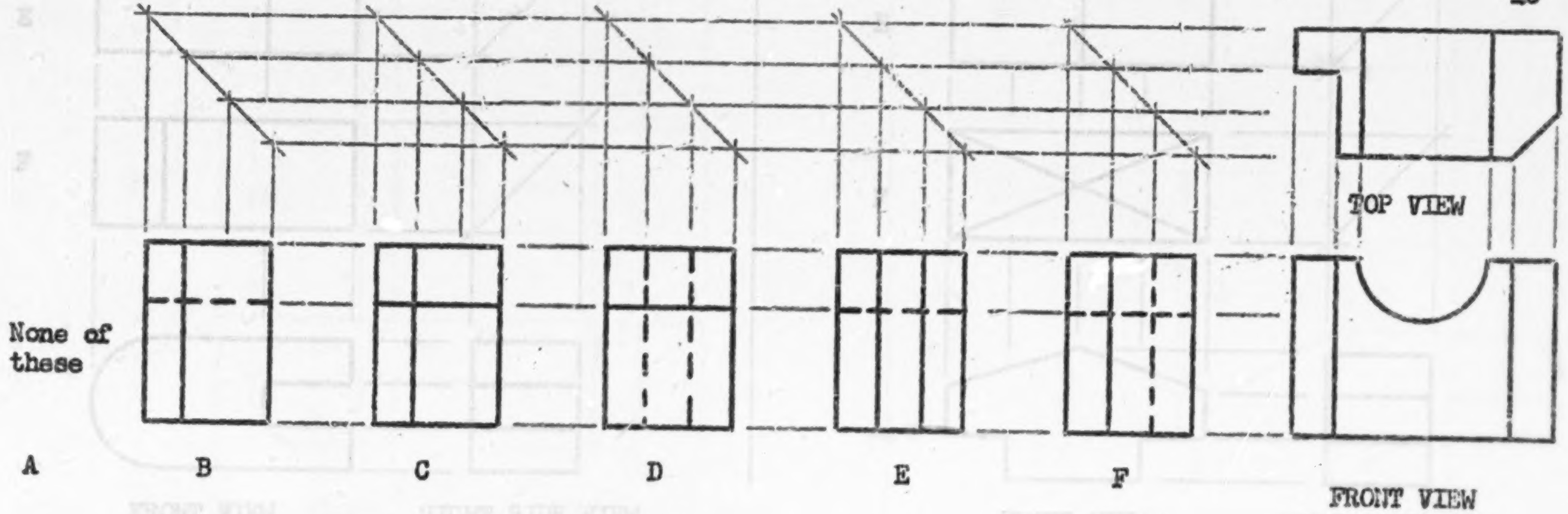
Choose correct left side view

15


None of these
A
B
C
D
E
F
TOP VIEW
FRONT VIEW

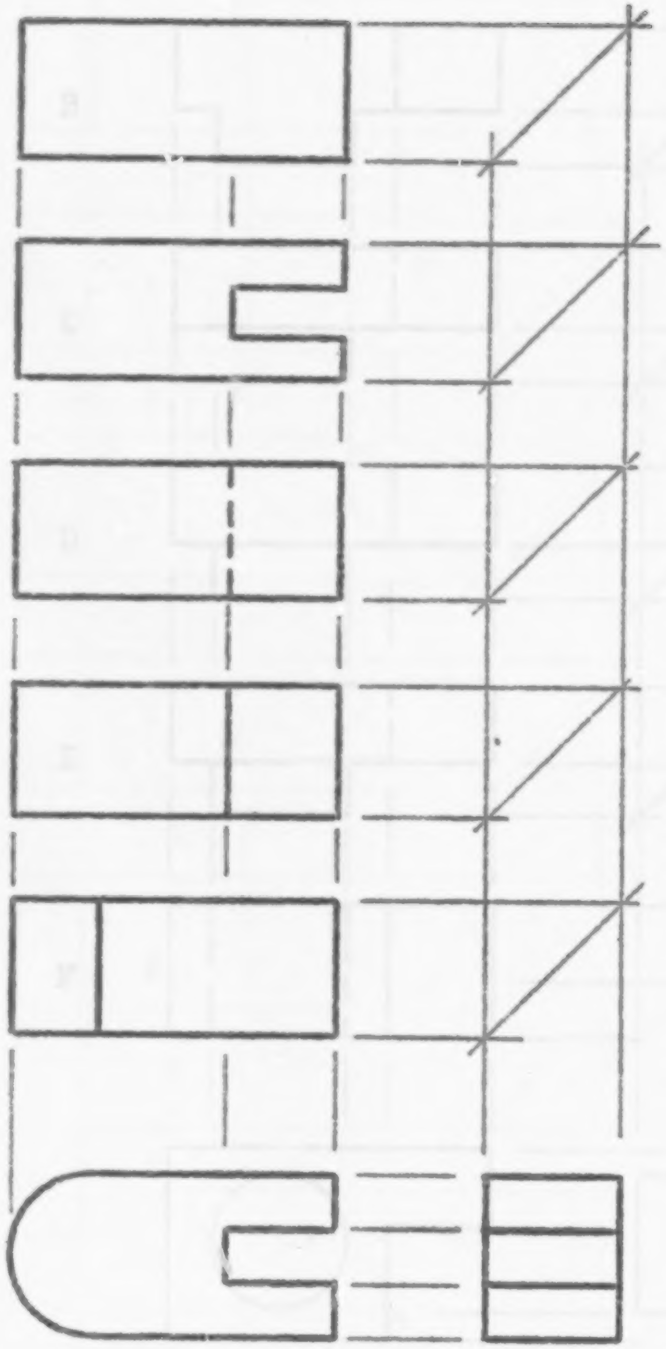
Choose correct left side view

16


None of these
A
B
C
D
E
F
TOP VIEW
FRONT VIEW

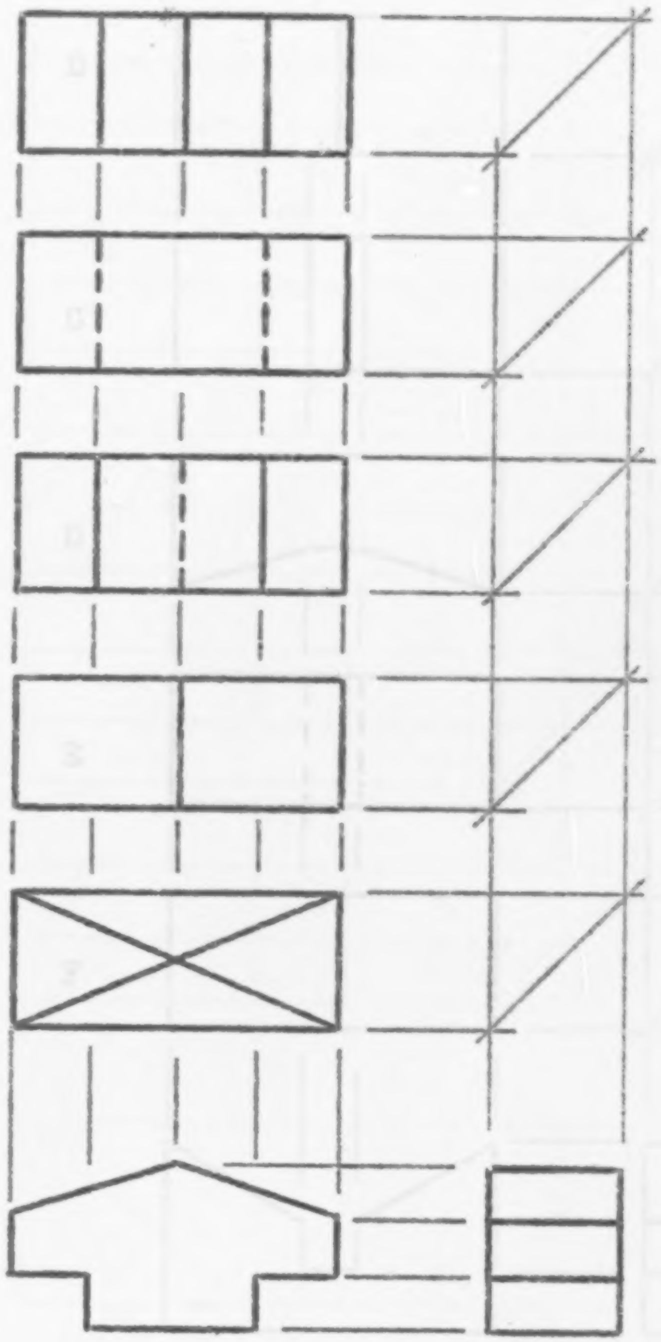
Choose correct left side view

A None of these



FRONT VIEW RIGHT SIDE VIEW
Choose correct top view

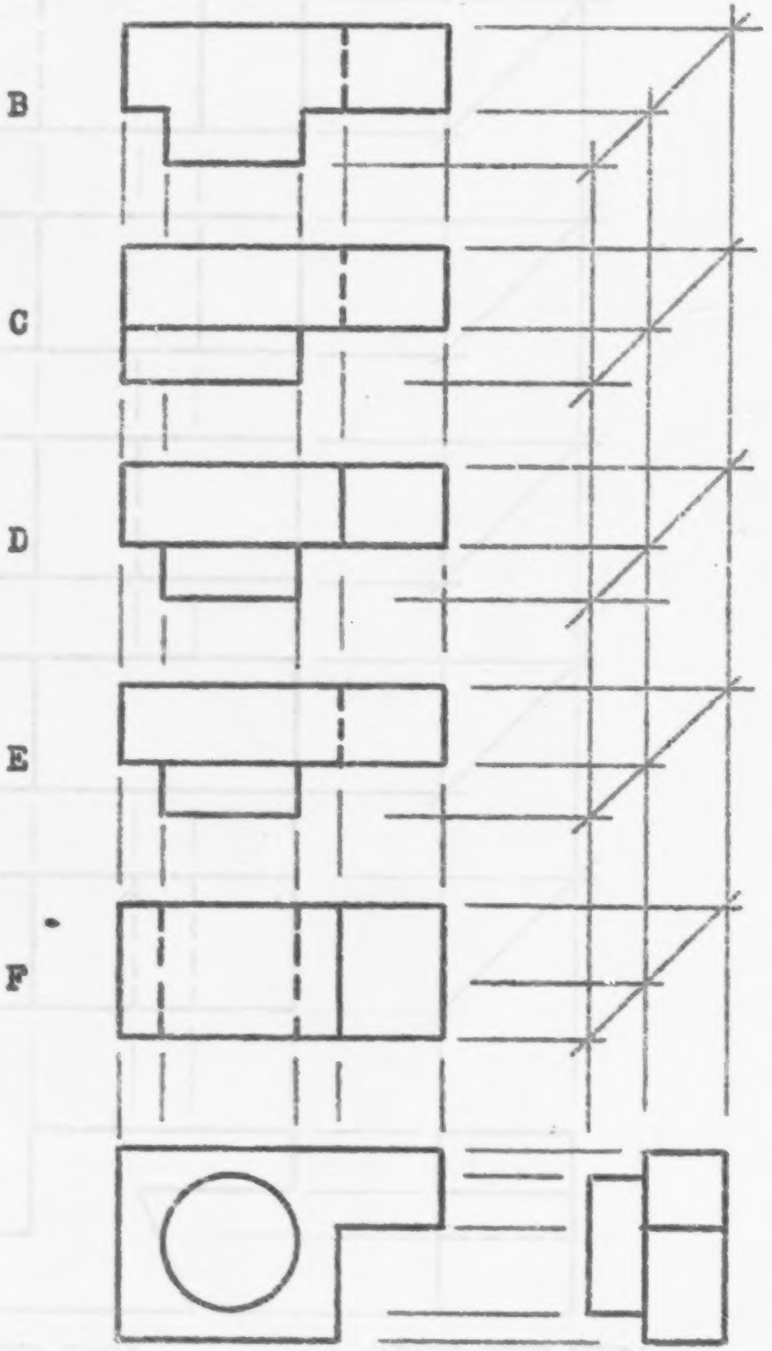
A None of these



FRONT VIEW RIGHT SIDE VIEW
Choose correct top view

19

A None of these

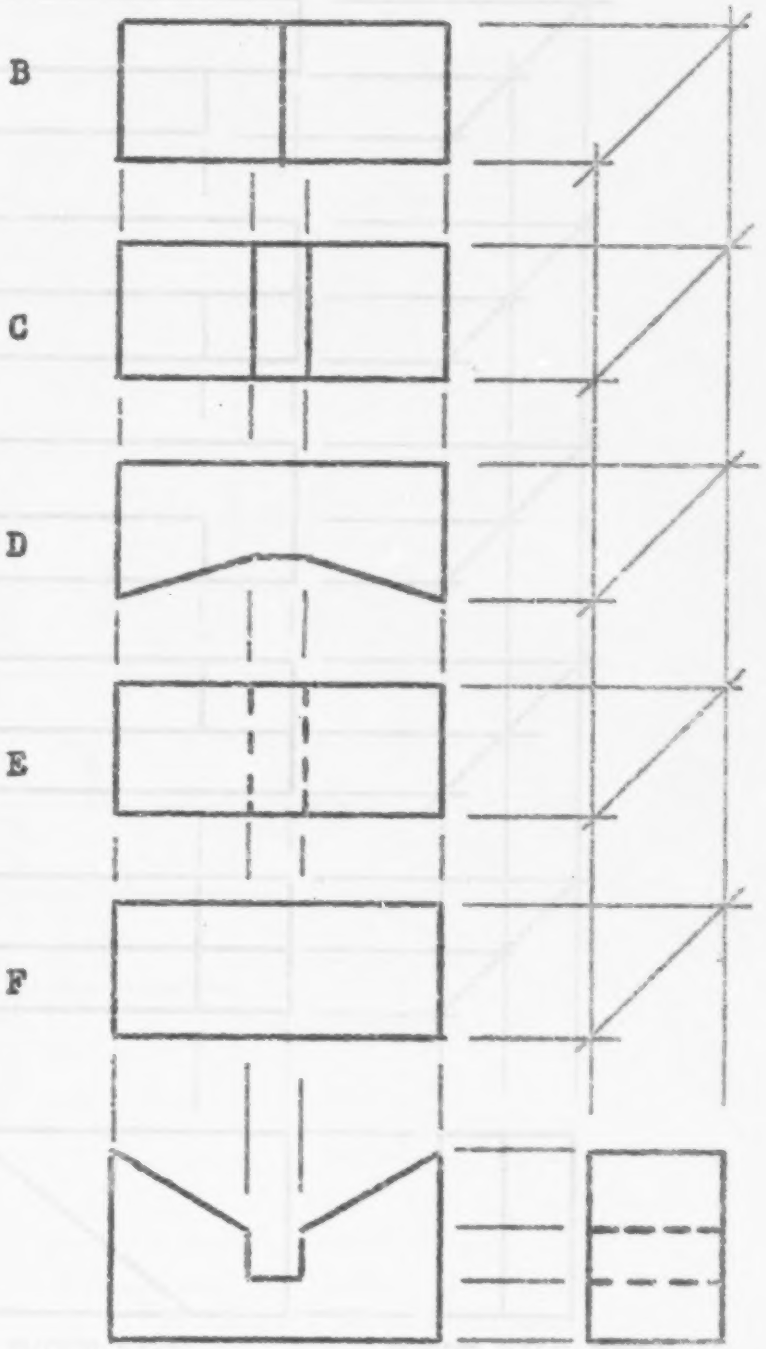


FRONT VIEW RIGHT SIDE VIEW

Choose correct top view

20

A None of these

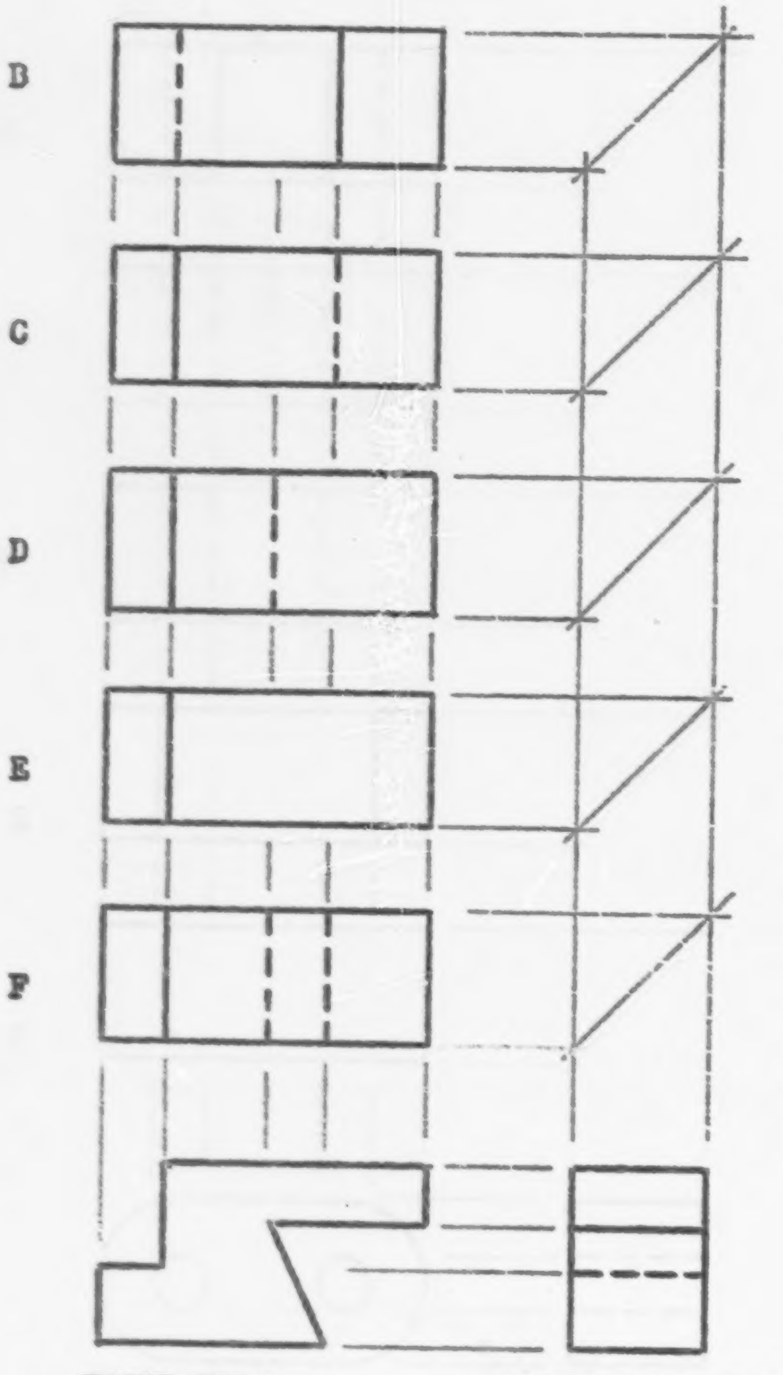


FRONT VIEW RIGHT SIDE VIEW

Choose correct top view

21

A None of those

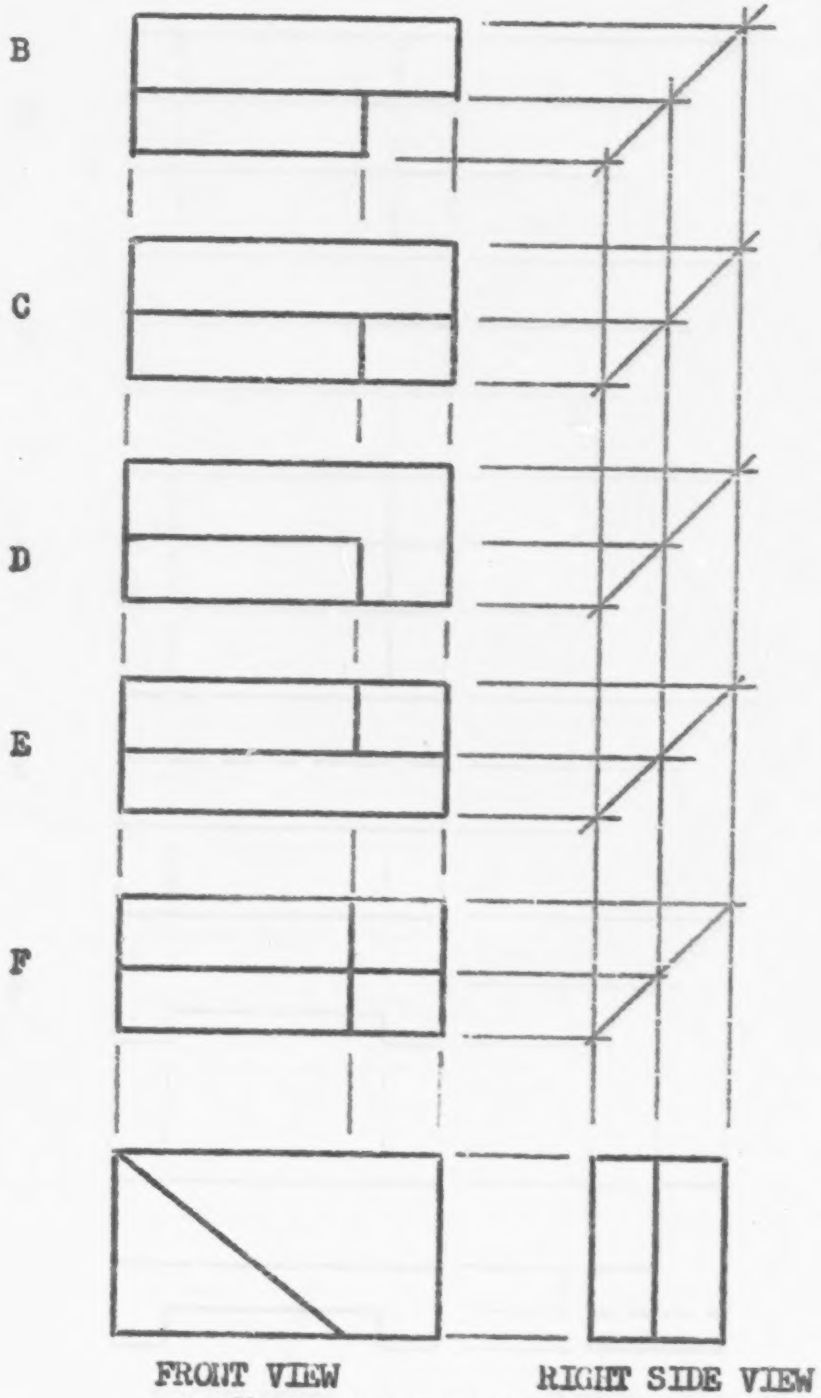


B
C
D
E
F
FRONT VIEW
RIGHT SIDE VIEW

Choose correct top view

22

A None of these

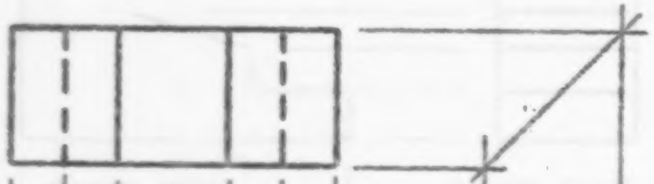


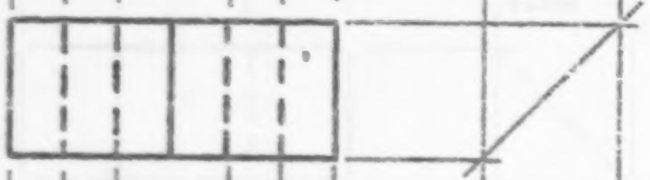
B
C
D
E
F
FRONT VIEW
RIGHT SIDE VIEW

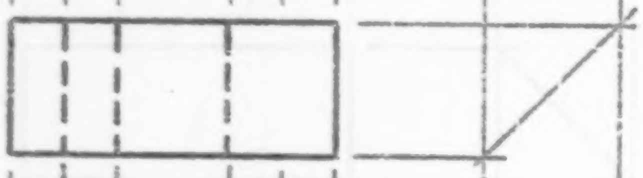
Choose correct top view

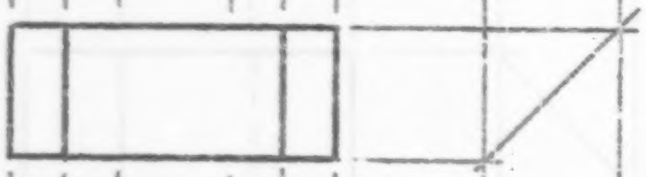
23

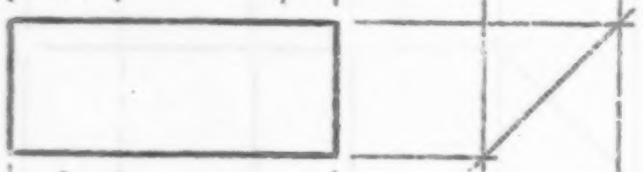
A None of these

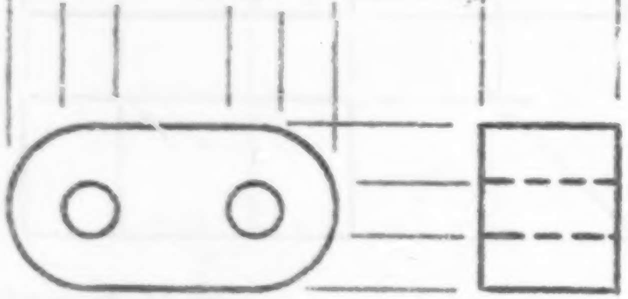
B


C


D


E


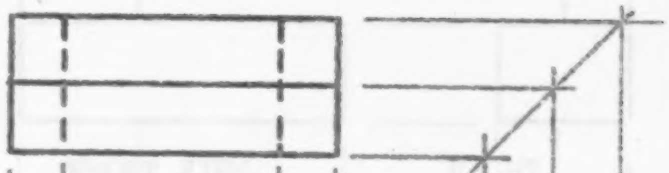
F


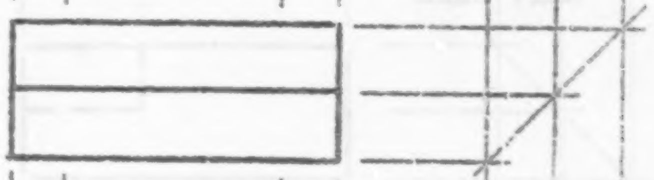

FRONT VIEW
RIGHT SIDE VIEW

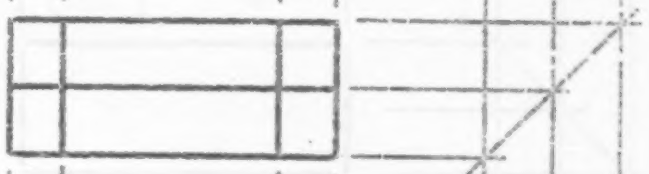
Choose correct top view

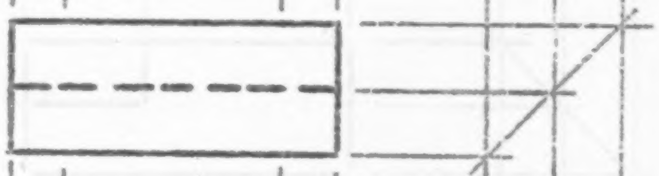
24

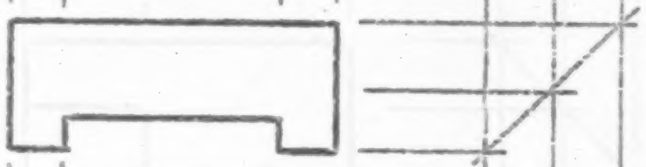
A None of these

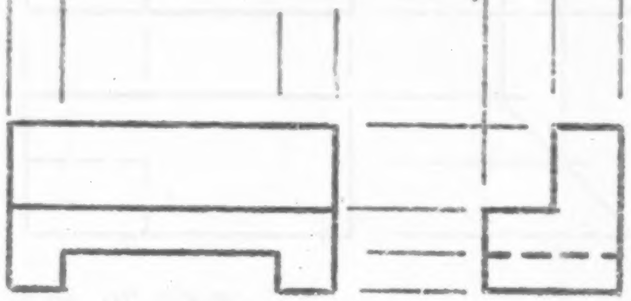
B


C


D


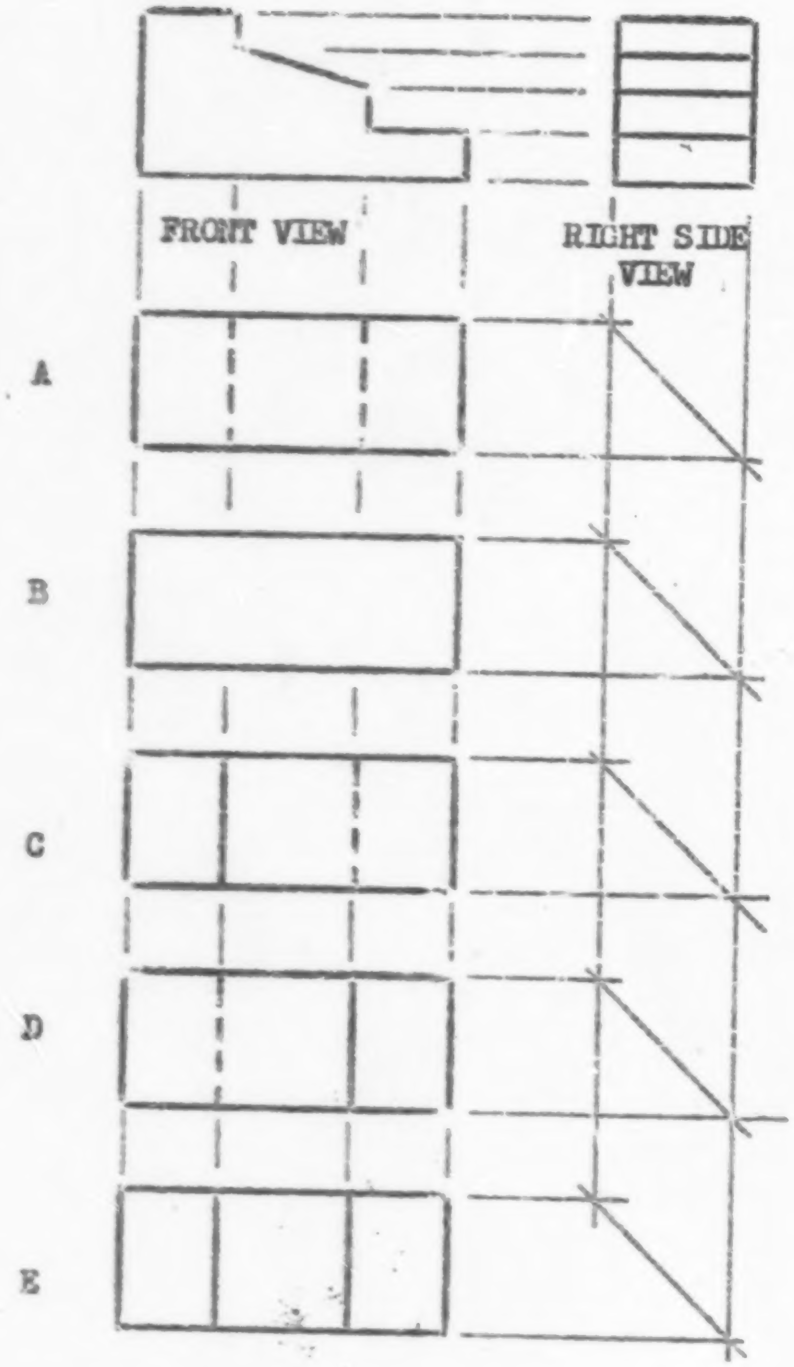
E


F



FRONT VIEW
RIGHT SIDE VIEW

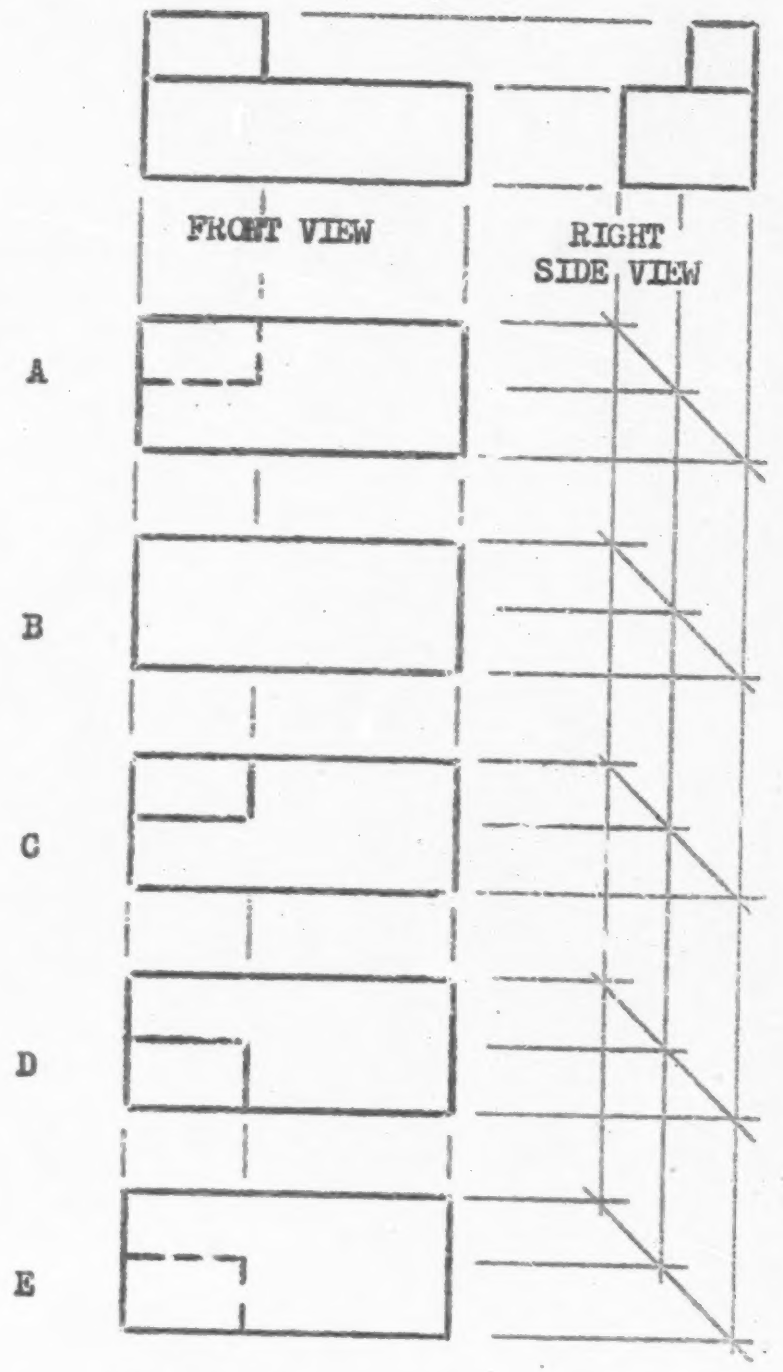
Choose correct top view

25


FRONT VIEW
RIGHT SIDE VIEW
A
B
C
D
E

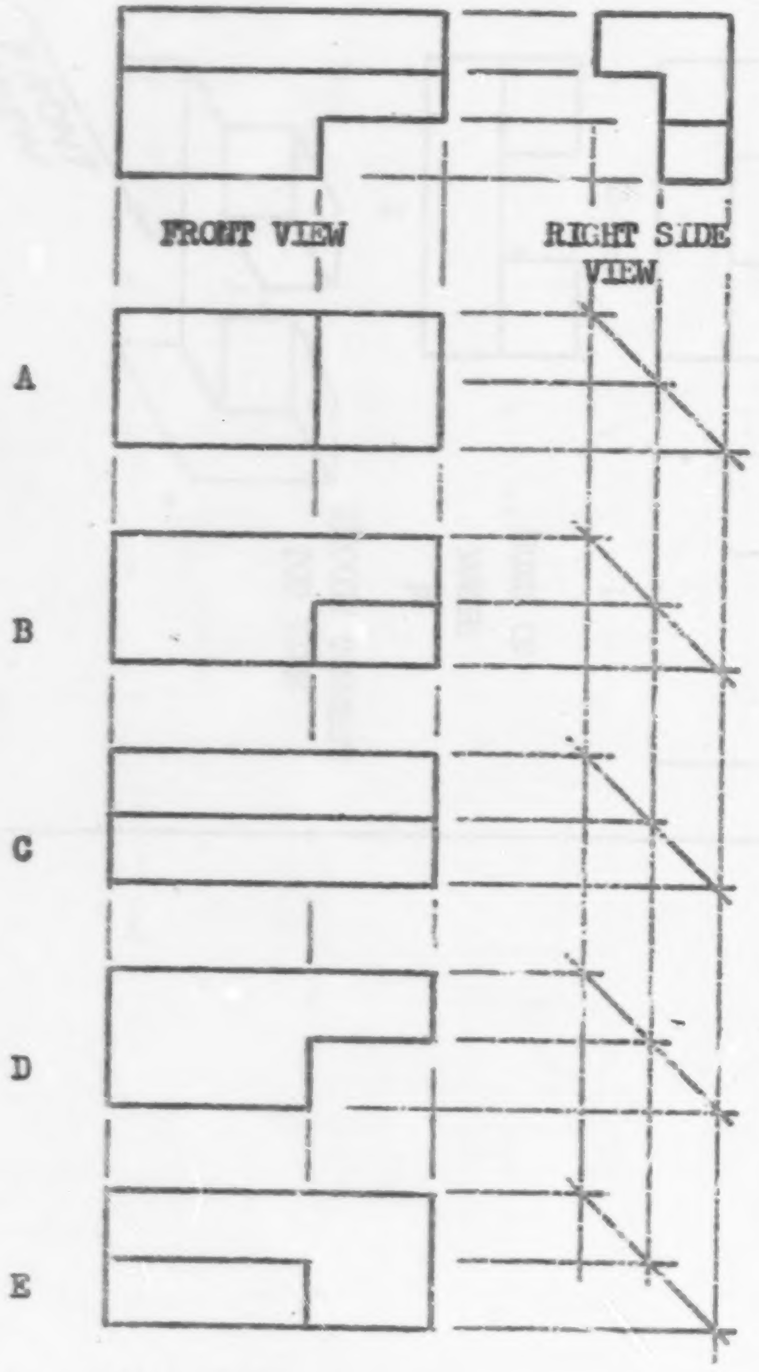
F None of these
Choose correct bottom view

26


FRONT VIEW
RIGHT SIDE VIEW
A
B
C
D
E

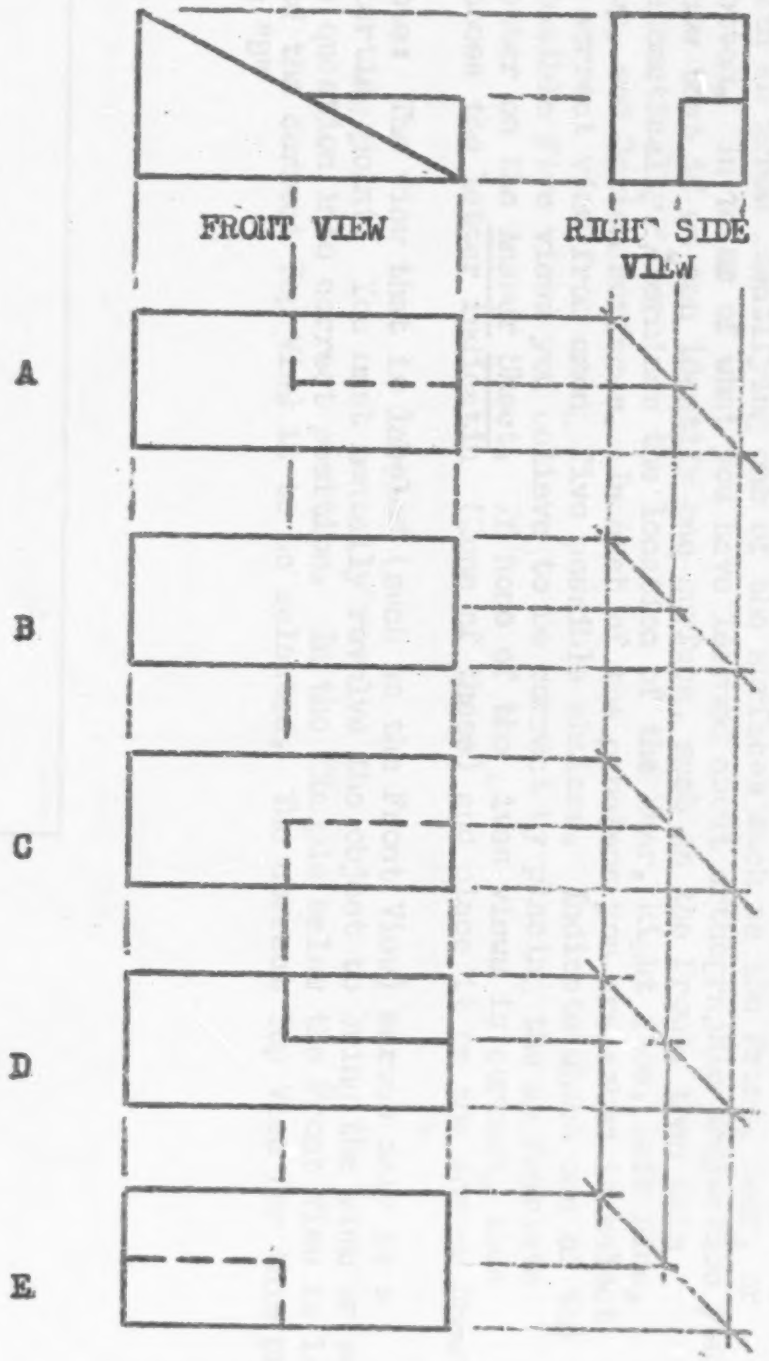
F None of these
Choose correct bottom view

27


FRONT VIEW
RIGHT SIDE VIEW
A
B
C
D
E

F None of these
Choose correct bottom view

28

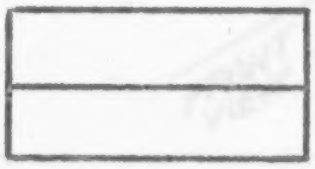

FRONT VIEW
RIGHT SIDE VIEW
A
B
C
D
E

F None of these
Choose correct bottom view

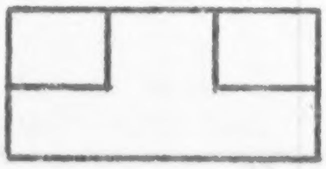
Directions: Problems 29-52

In each of the following problems a pictorial (picture-type) drawing is given with an arrow identifying one of the surfaces such as the Front, Rear, or Bottom. In terms of what you have learned about orthographic projection you know that if we can identify one surface, such as the Front, then this automatically determines the location of the Rear, Right Side, Left Side, Top, and Bottom surfaces. In each of the problems you are asked to select a correct view from among five possible choices. Indicate which one of the possible five views you believe to be correct by placing the appropriate letter on the Answer Sheet. If none of the given views is correct, then choose the letter indicating (None of these) and place it on the Answer Sheet.

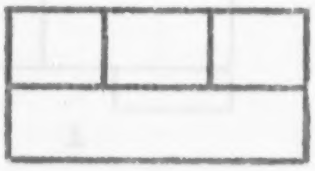
Note: The view that is labeled (such as the Front View) serves only as a starting point. You must mentally revolve the object to bring the view or surface in question into correct position. In the Example below the Front View is labeled and the correct Top View is to be selected. The correct Top View for this problem is "B"



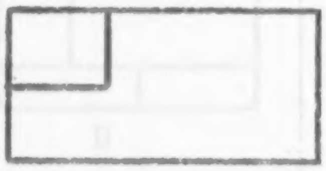
A



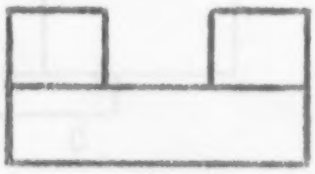
B



C



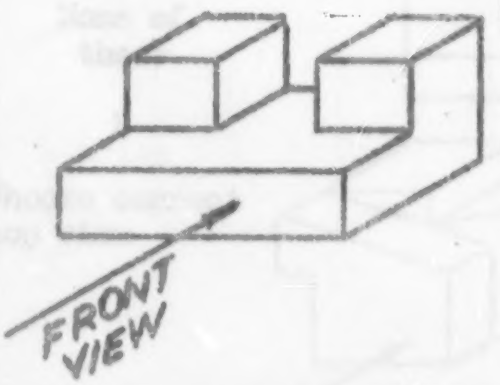
D



E

NONE OF THESE
F

CHOOSE CORRECT
TOP VIEW



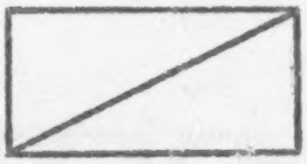
B ______ X2

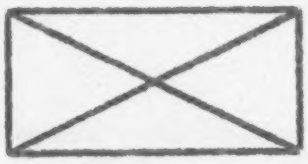
______ 29

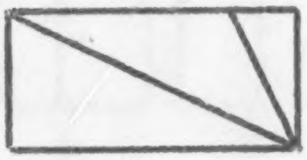
______ 30

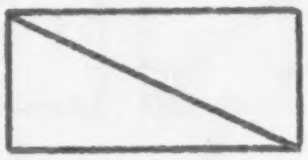
______ 31

29


A

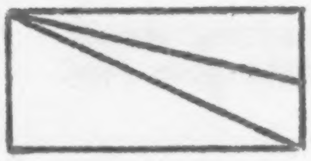

B


C

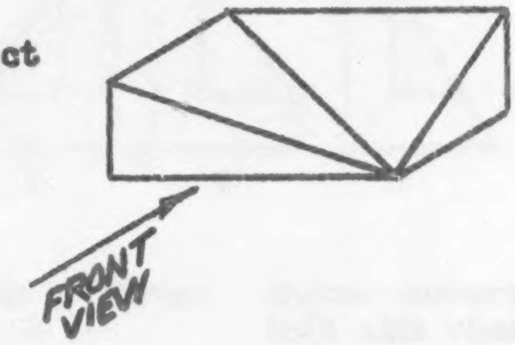

D

None of these

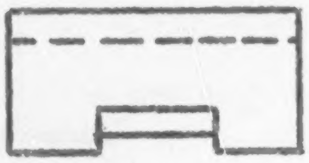
E

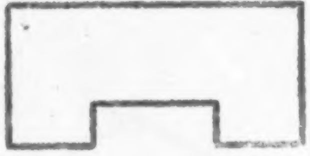

F

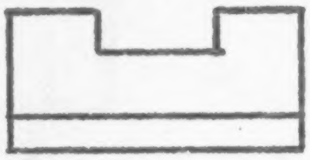
Choose correct top view

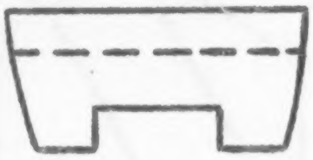


30


A

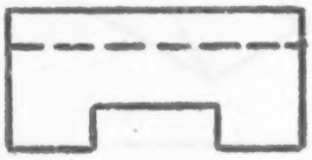

B


C

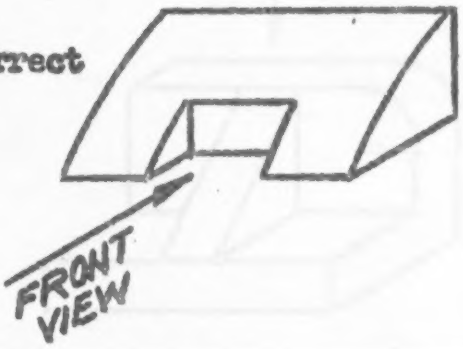

D

None of these

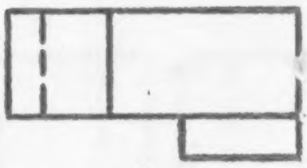
E

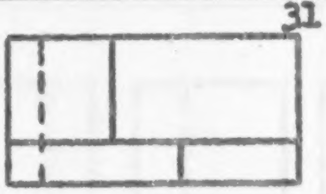

F

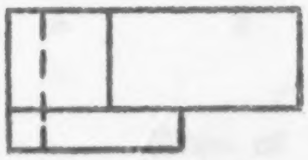
Choose correct top view

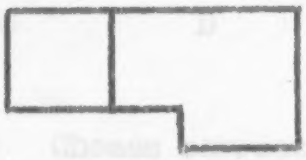


31


A

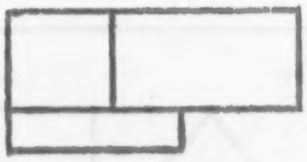

B


C


D

None of these

E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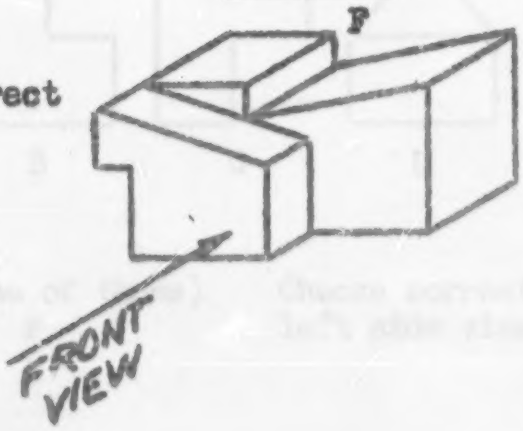

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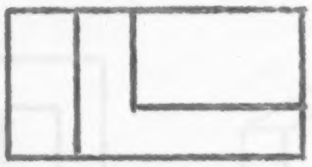
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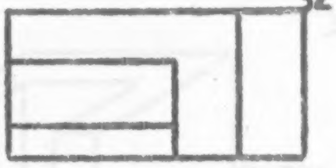
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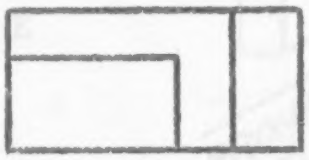
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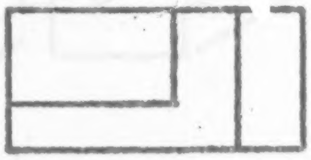
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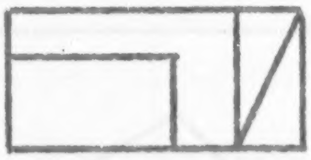
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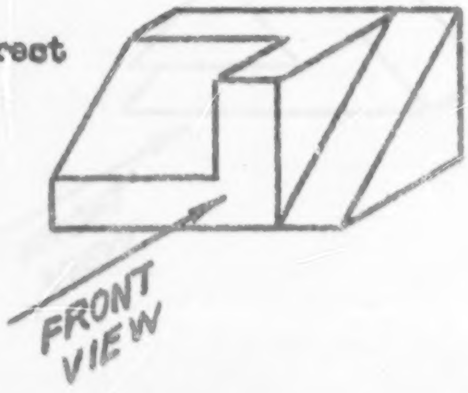

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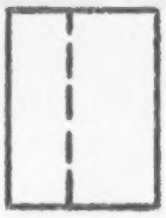
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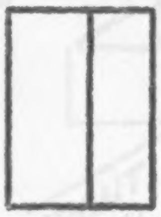
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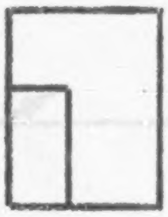
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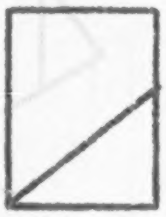
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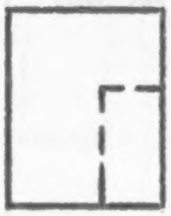
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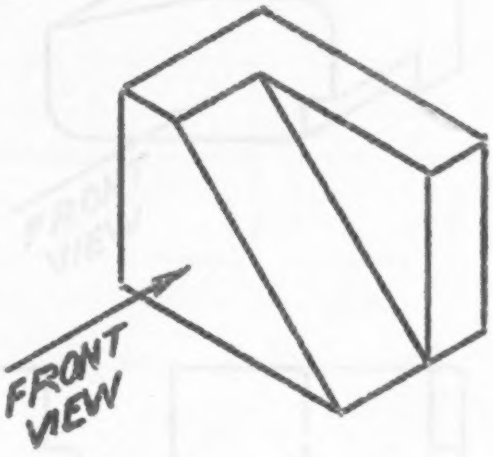

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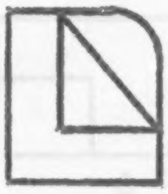
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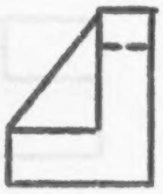
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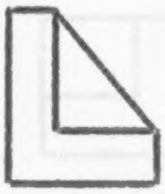
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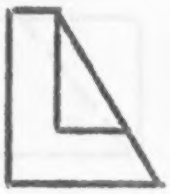
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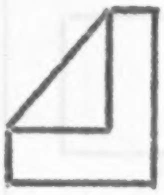
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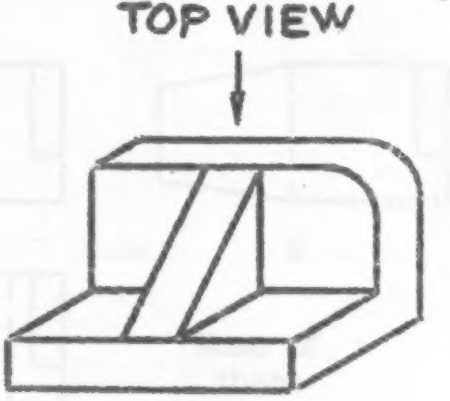

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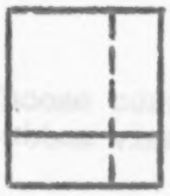
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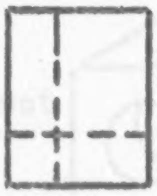
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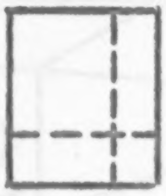
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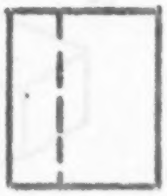
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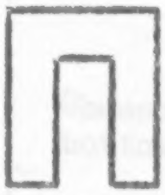
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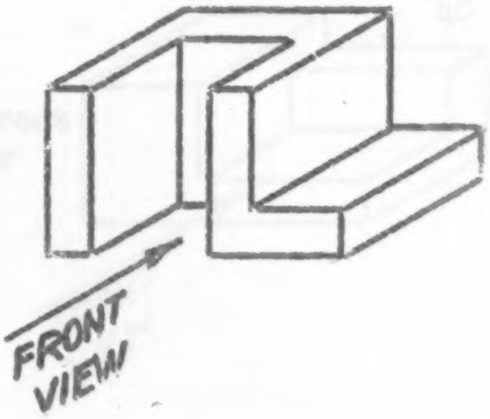

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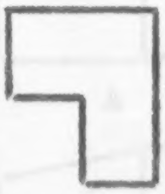
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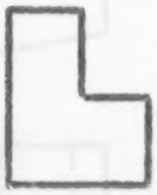
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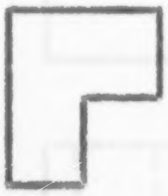
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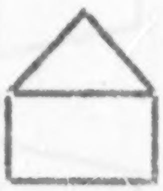
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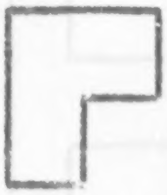
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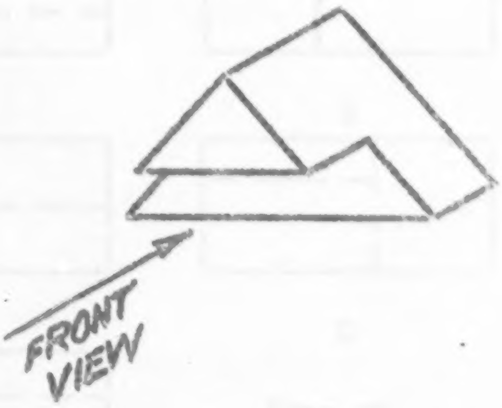

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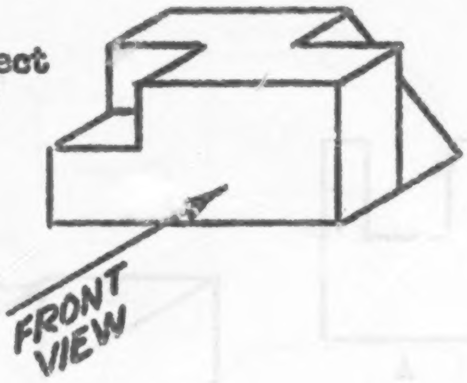

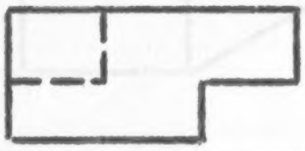
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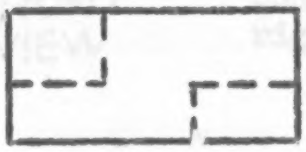
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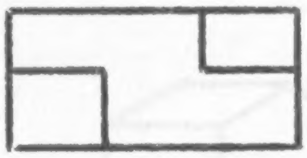
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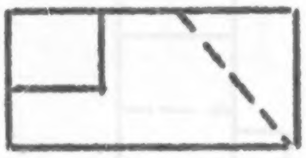
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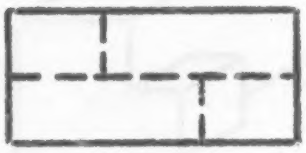
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38

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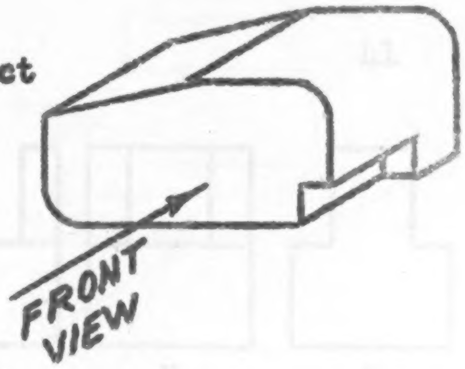

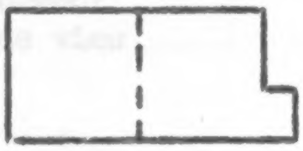
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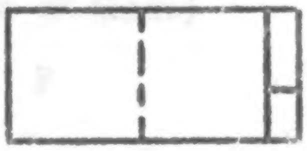
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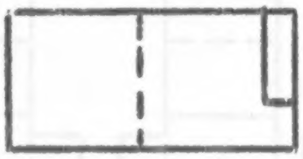
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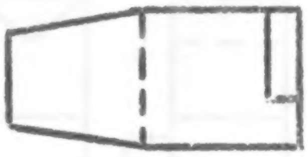
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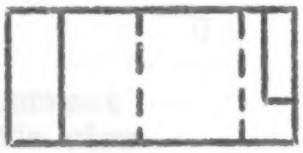
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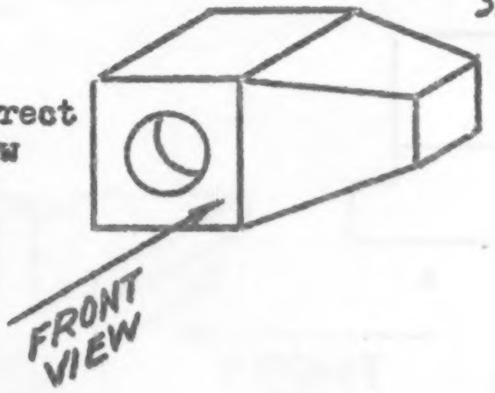
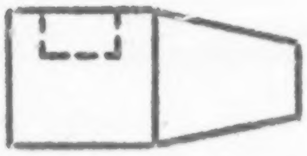
Choose correct bottom view

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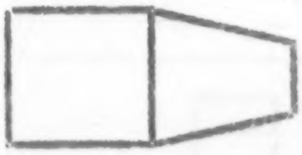
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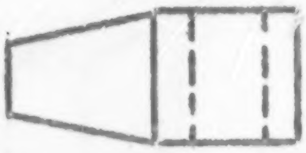
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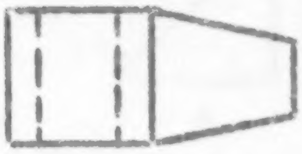
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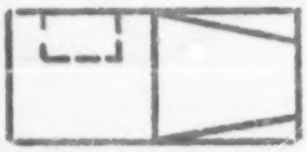
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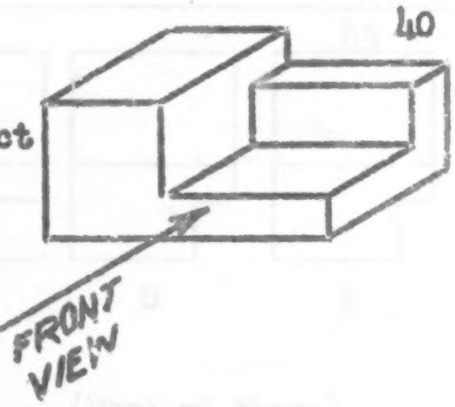
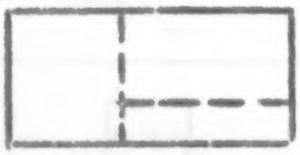
Choose correct bottom view

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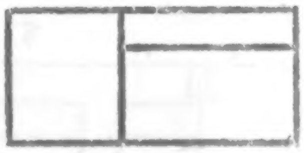
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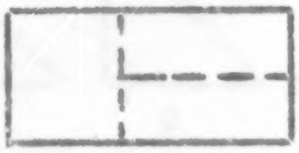
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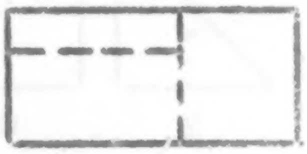
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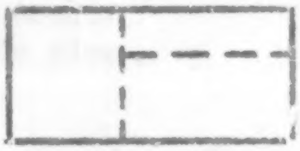
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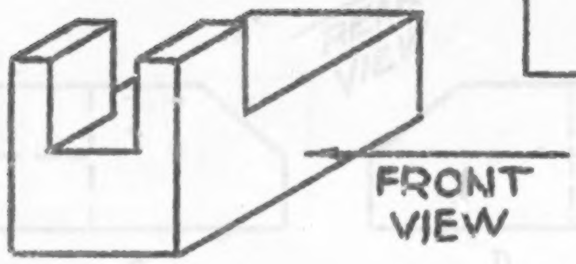

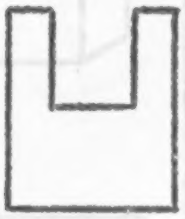
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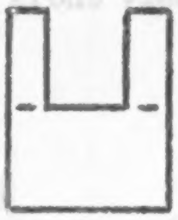
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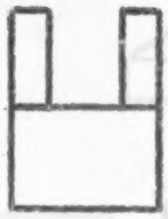
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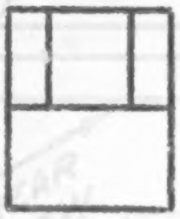
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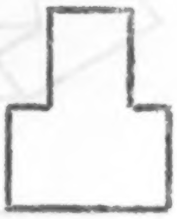
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Choose correct right side view

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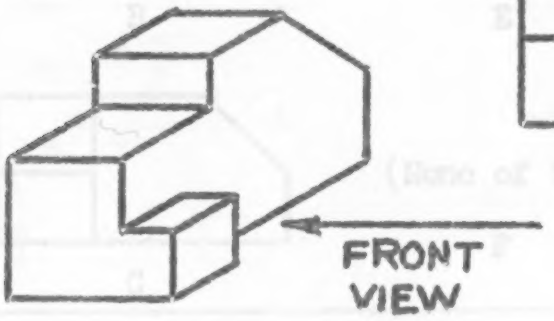

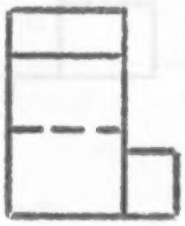
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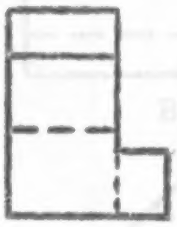
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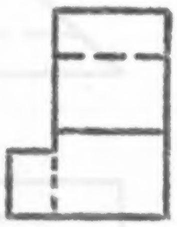
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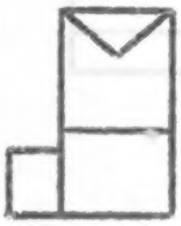
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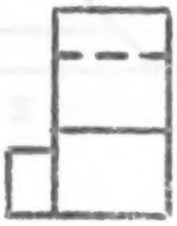
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Choose correct right side view

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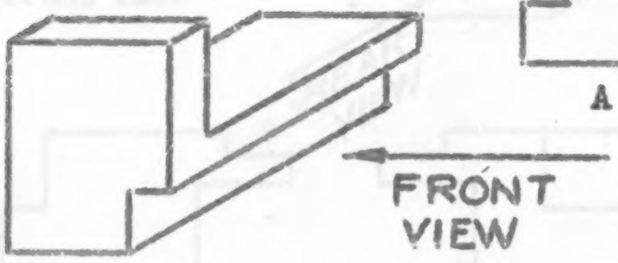

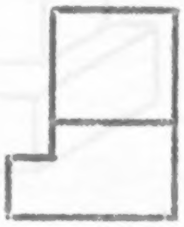
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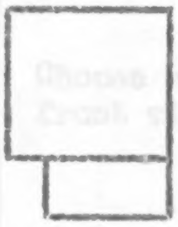
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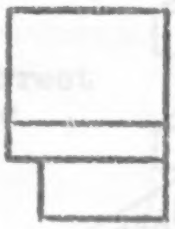
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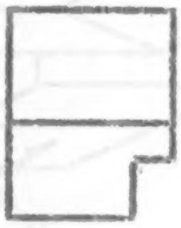
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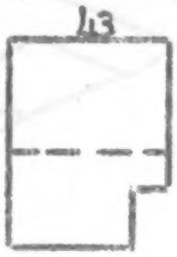
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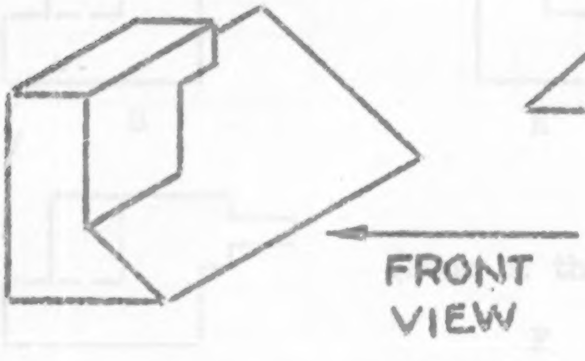
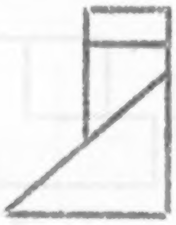
Choose correct right side view

(None of these)

F

44

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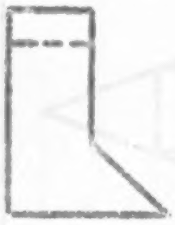
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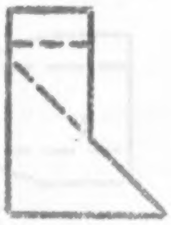
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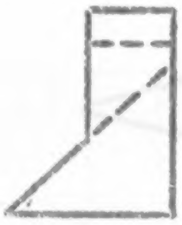
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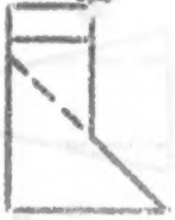

E

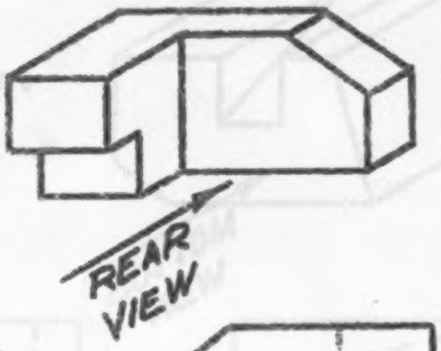
Choose correct right side view

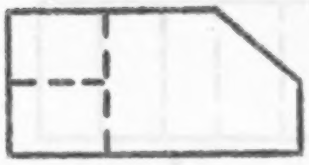
(None of these)

F

45

Choose
correct
front view

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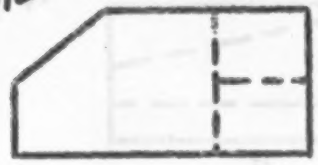
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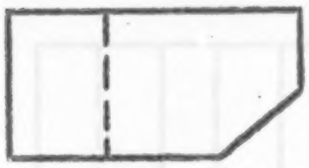
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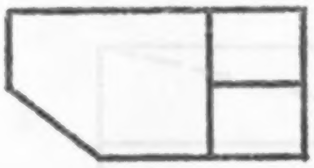
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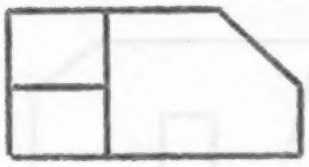
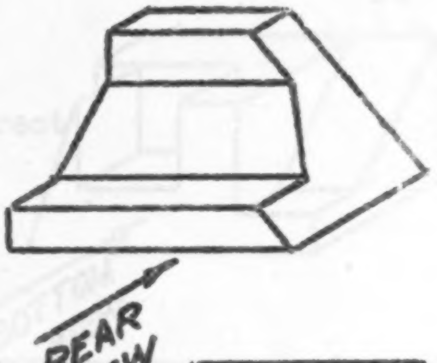

C

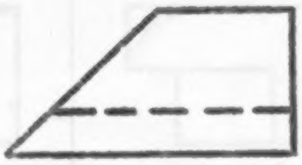
(None of these)

F

46

Choose correct
front view

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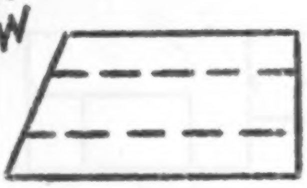
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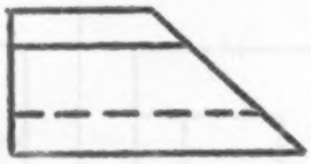
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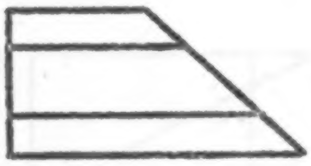
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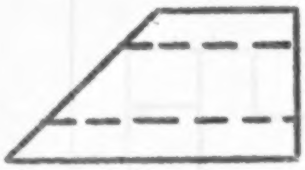
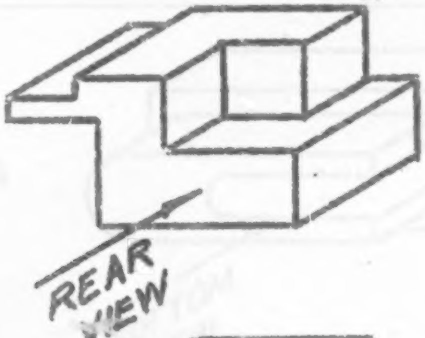

C

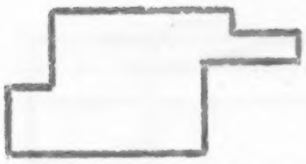
(None of these)

F

47

Choose
correct
front view

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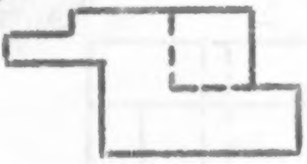
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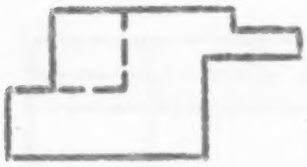
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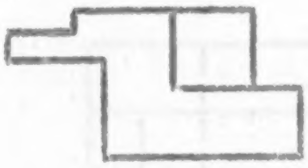
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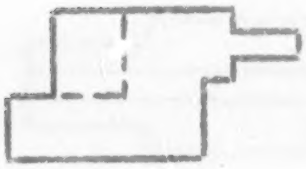
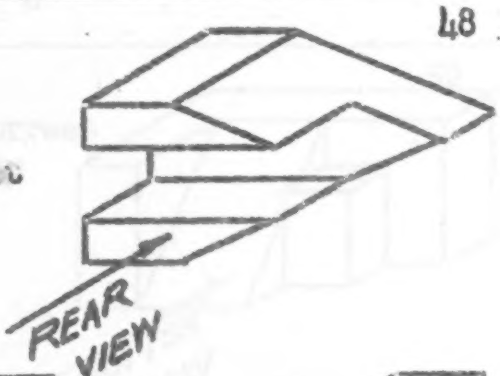

C

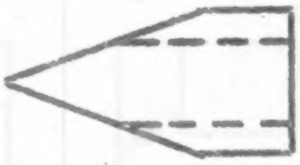
(None of these)

F

48

Choose correct
front view

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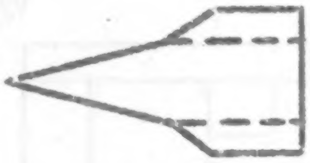
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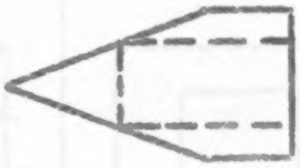
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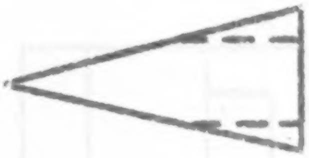
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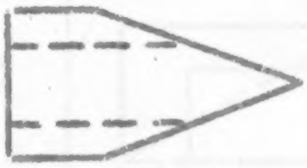
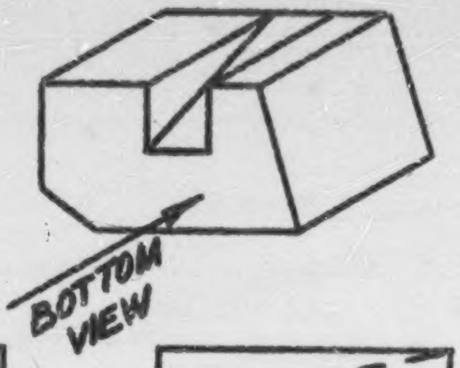

C

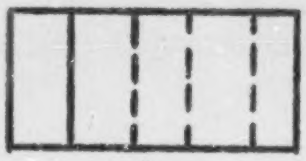
(None of these)

F

49

Choose correct front view


BOTTOM VIEW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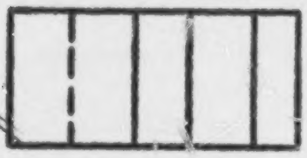
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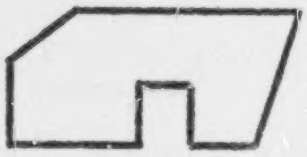
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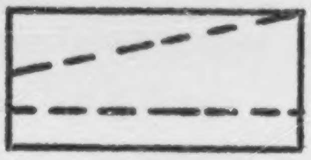
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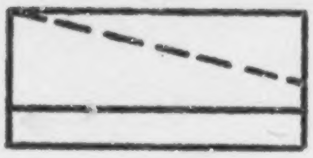
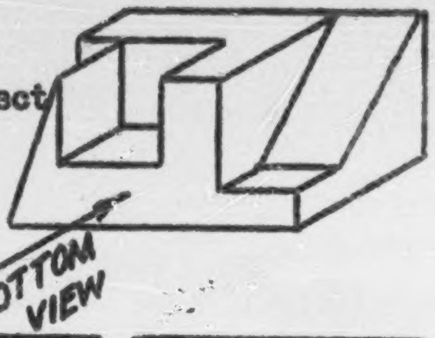

E

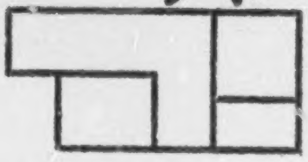
(None of these)

F

50

Choose correct front view


BOTTOM VIEW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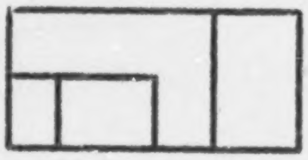
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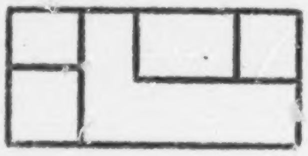
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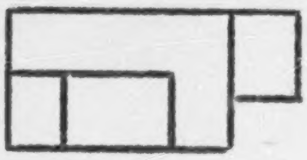
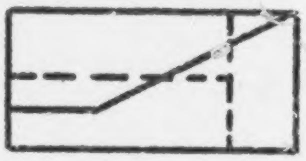

D

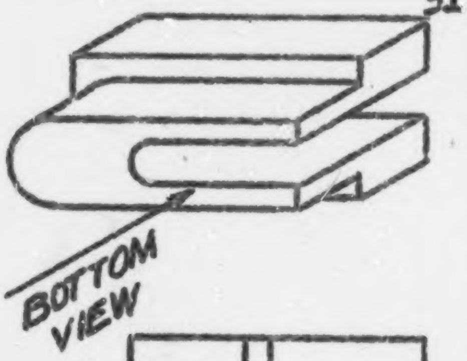

E

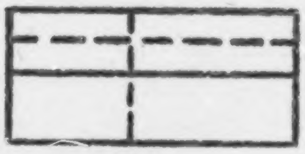
(None of these)

F

51

Choose correct front view


BOTTOM VIEW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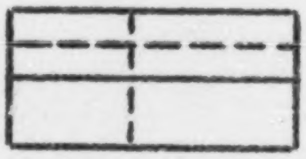
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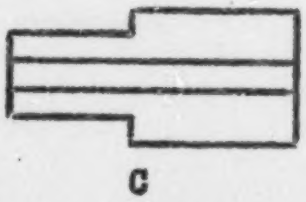
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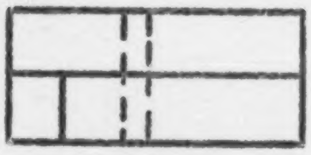
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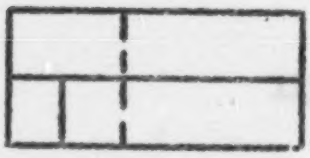
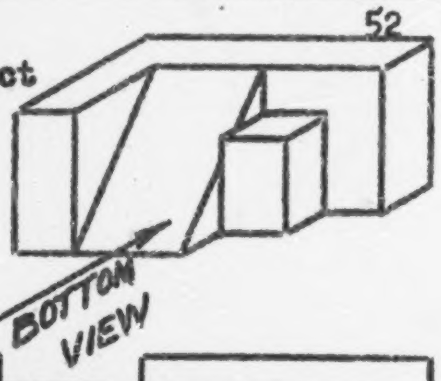

E

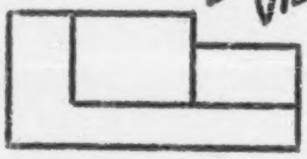
(None of these)

F

52

Choose correct front view


BOTTOM VIEW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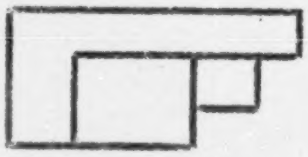
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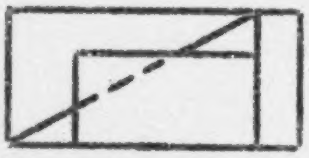
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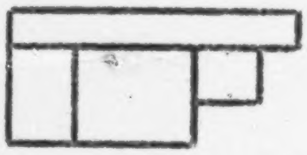
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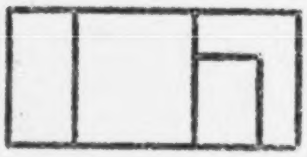

E

(None of these)

F

APPENDIX D

CRITERION TESTS - TRANSFER

Name________________________________ Research Group Number__________

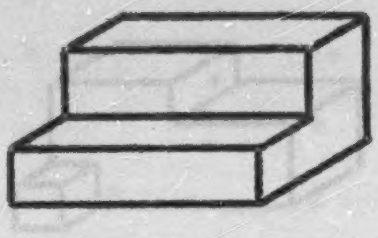
Transfer Test: Part 1

Directions: The taped instruction which you received relates indirectly to the test items in this booklet. Think through each problem very carefully and choose the answer which you believe to be correct. Make a "best guess" in the event that you are uncertain of the answer.

ANSWER SHEET

________ 1
________ 2
________ 3
________ 4
________ 5
________ 6
________ 7
________ 8
________ 9
________ 10
________ 11
________ 12
________ 13
________ 14
________ 15
________ 16
________ 17
________ 18
________ 19
________ 20

1



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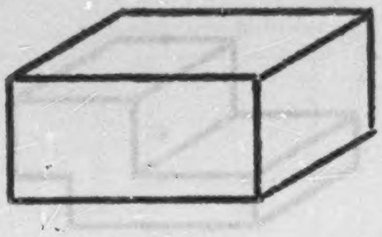

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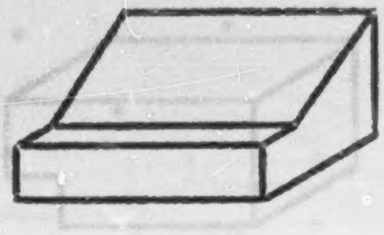
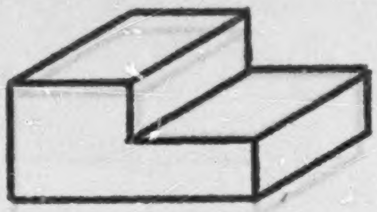
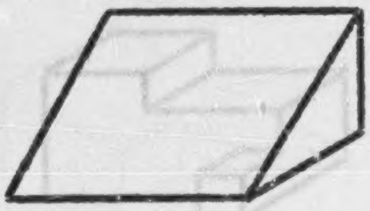


C



D



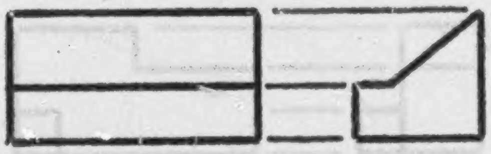
E

None of these

F

Choose the block that matches the orthographic drawing.

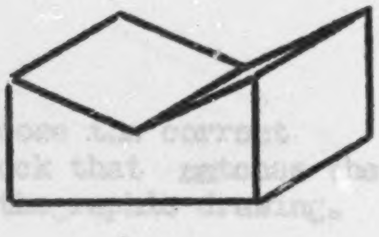
Note: Hidden lines are not included in the pictoral drawing of the block.



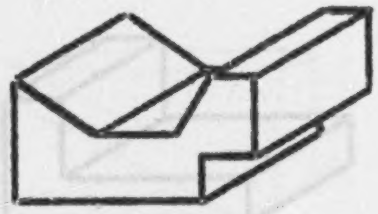
Front View

Right Side View

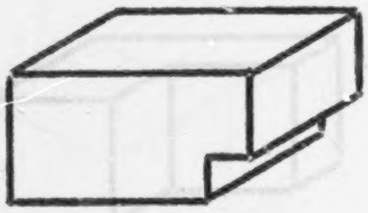
2



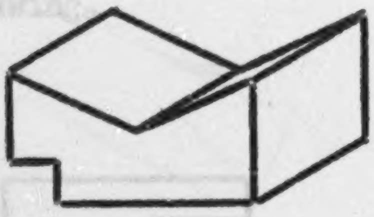
A



B



C



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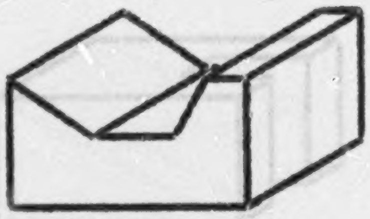


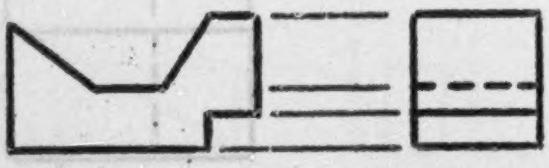
E

None of These

F

Choose the block that matches the orthographic drawing.

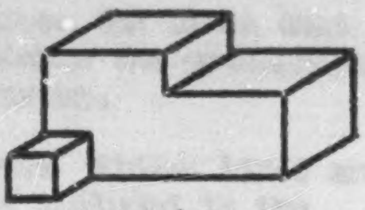
Note: Hidden lines are not included in the pictorial drawing of the block.



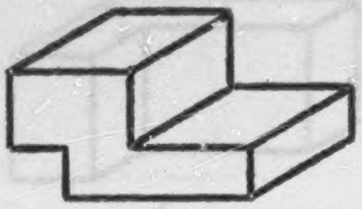
Front View

Right Side View

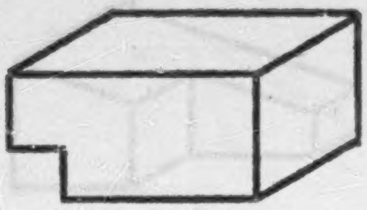
3



A



B



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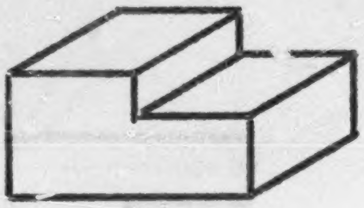
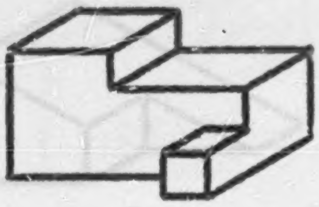


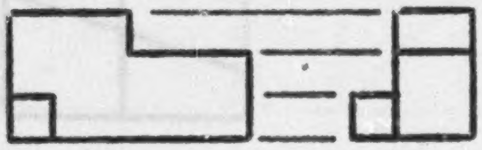
D



E

None of these

F



Front View

Right Side View

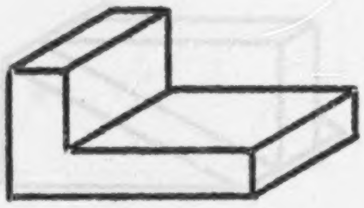
Choose the block that matches the orthographic drawing.

Note: Hidden lines are not included in the pictorial drawing of the block.

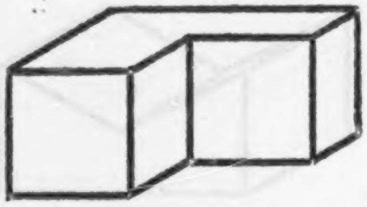
4

Choose the correct block that matches the orthographic drawing.

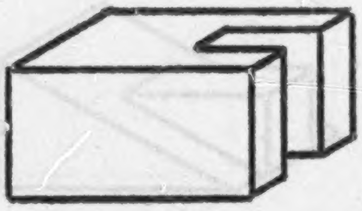
Note: Hidden lines are not included in the pictorial drawing.



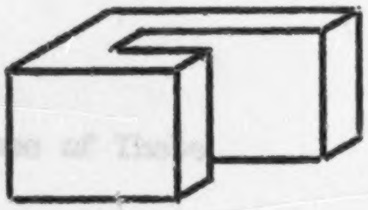
A



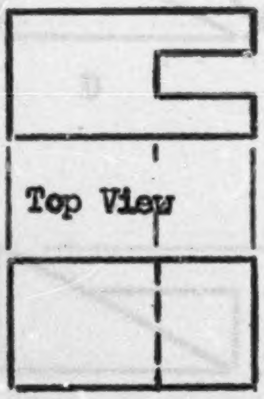
B



C

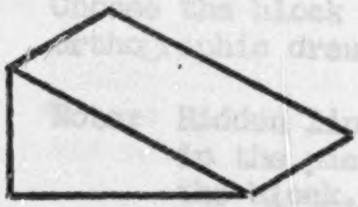


D



Top View

Front View



E

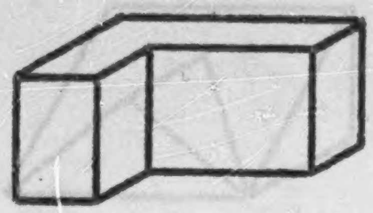
None of these

F

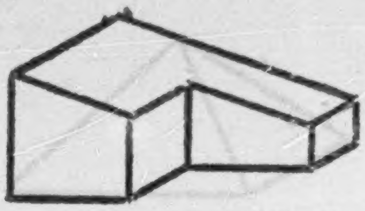
5

Choose the block that matches the orthographic drawing.

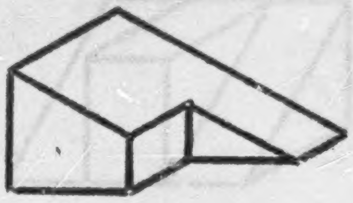
Note: Hidden lines are not included in the pictorial drawing of the block.



A



B



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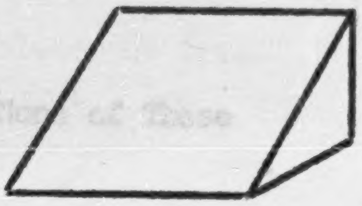

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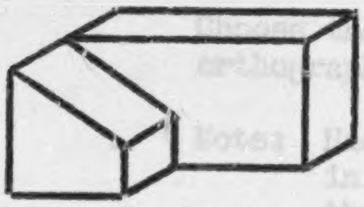
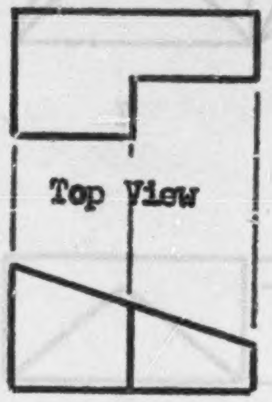


E

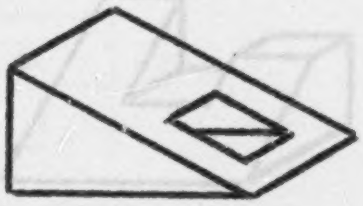
None of These

F

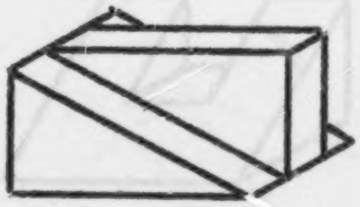


Front View

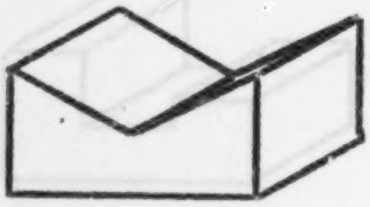
6



A



B



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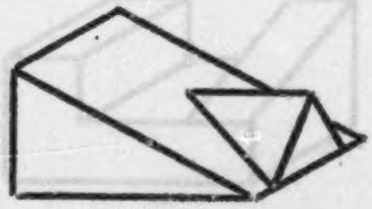

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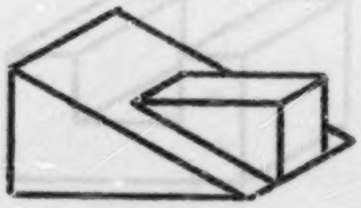


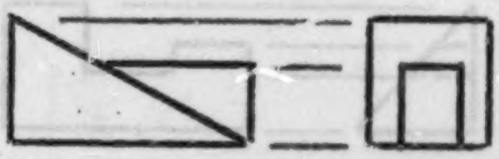
E

None of These

F

Choose the block that matches the orthographic drawing.

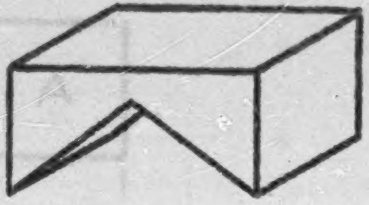
Note: Hidden lines are not included in the pictorial drawing of the block.



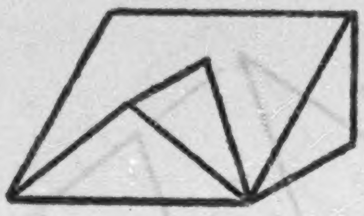
Front View

Right Side View

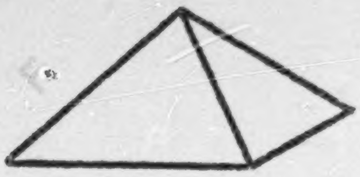
7



A



B



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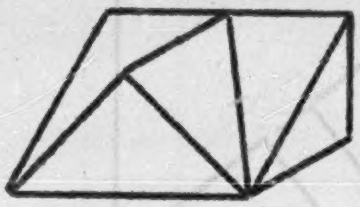
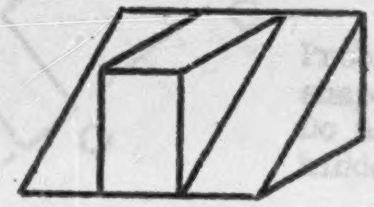


D



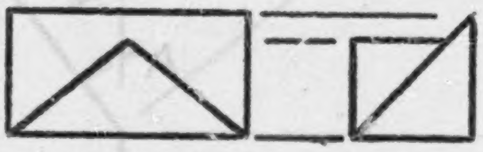
E

None of These

F

Choose the block that matches the orthographic drawing.

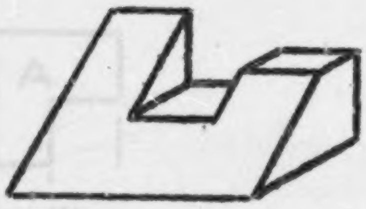
Note: Hidden lines are not included in the pictorial drawing of the block.



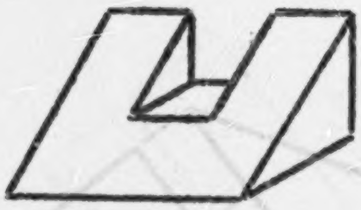
Front View

Right Side View

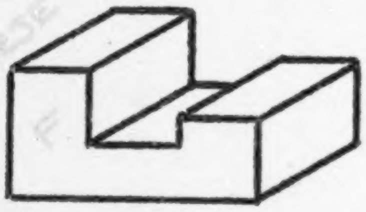
8



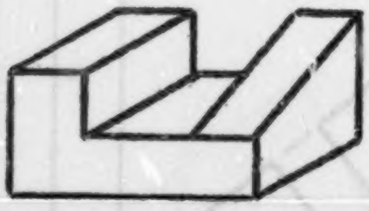
A



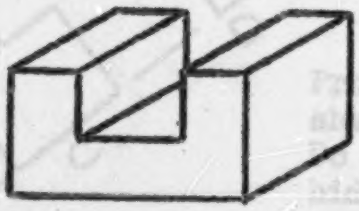
B



C



D



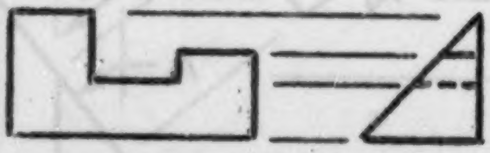
E

None of These

F

Choose the block that matches the orthographic drawing.

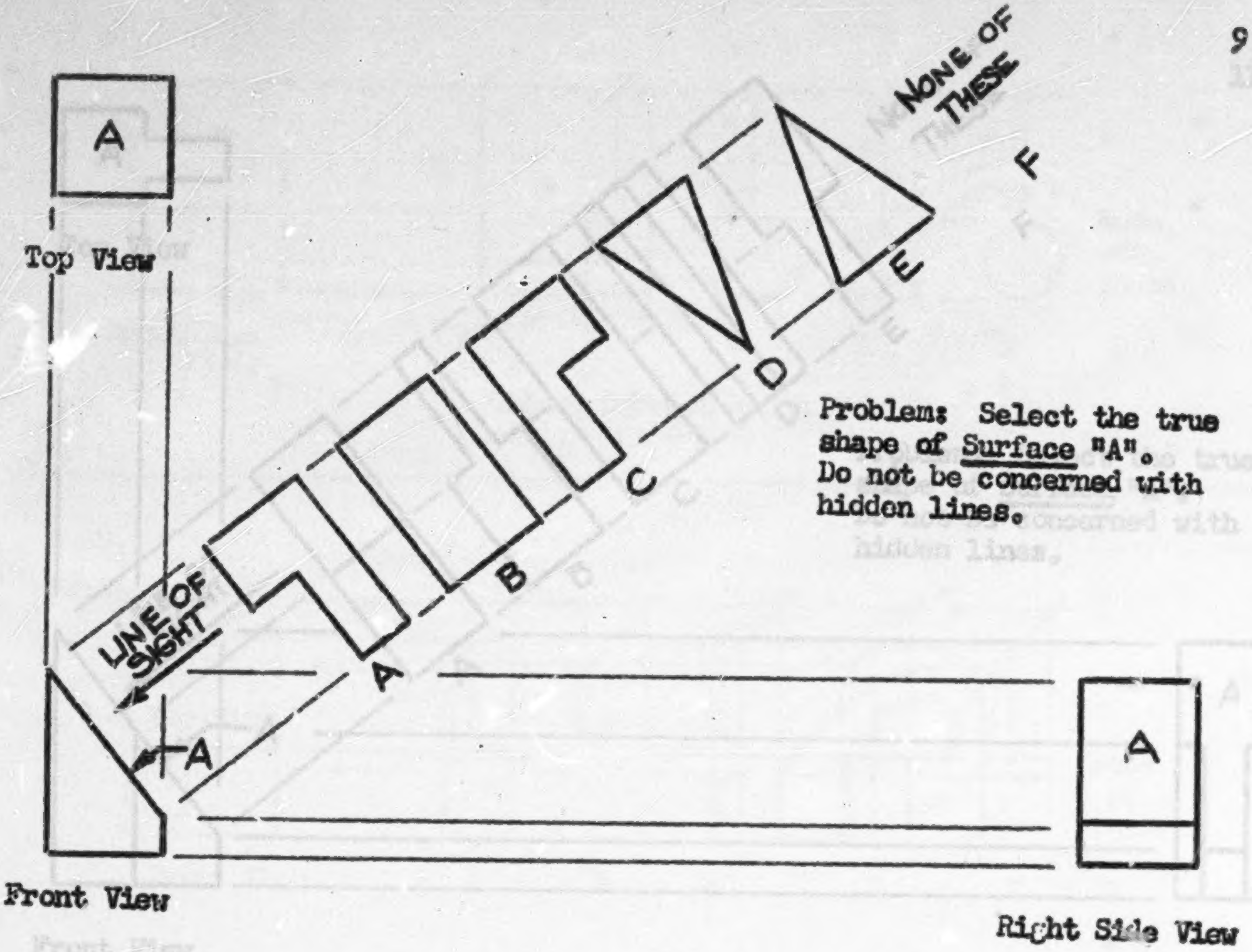
Note: Hidden lines are not included in the pictorial drawing of the block.



Front View

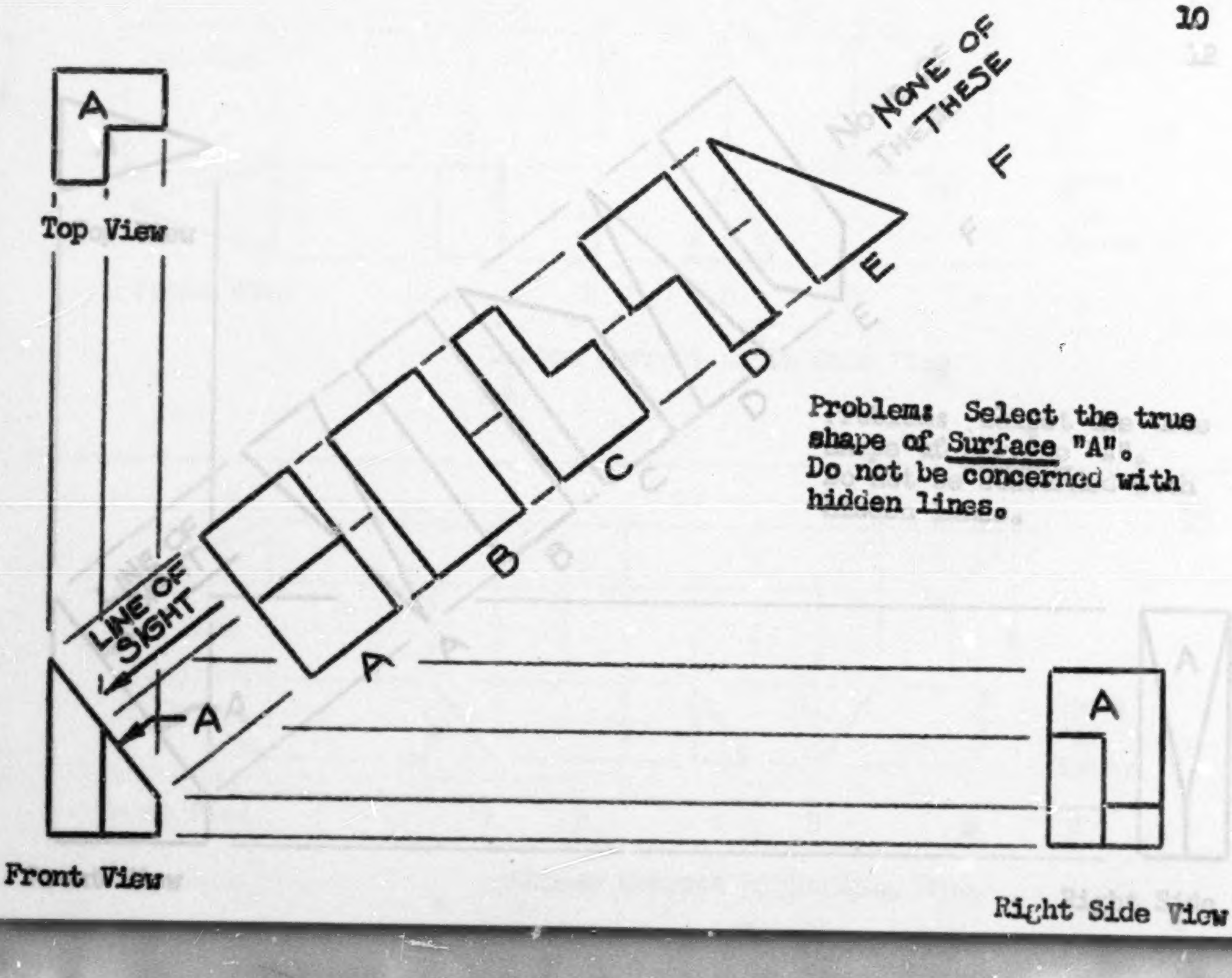
Right Side View

9


A
Top View
NONE OF THESE
F
E
D
C
B
A
LINE OF SIGHT
A
A
Front View
Right Side View

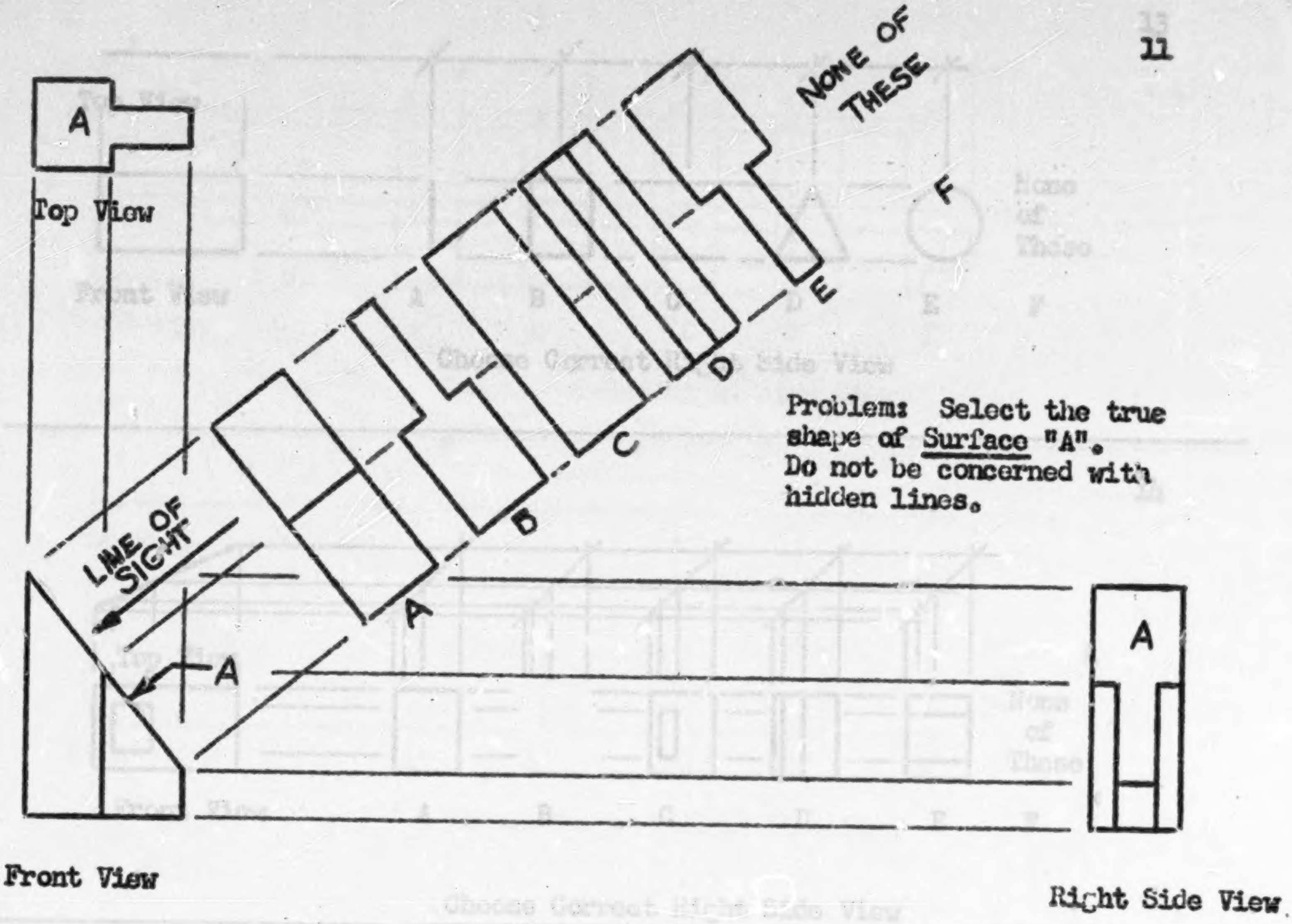
Problem: Select the true shape of Surface "A". Do not be concerned with hidden lines.

10


A
Top View
NONE OF THESE
F
E
D
C
B
A
LINE OF SIGHT
A
A
Front View
Right Side View

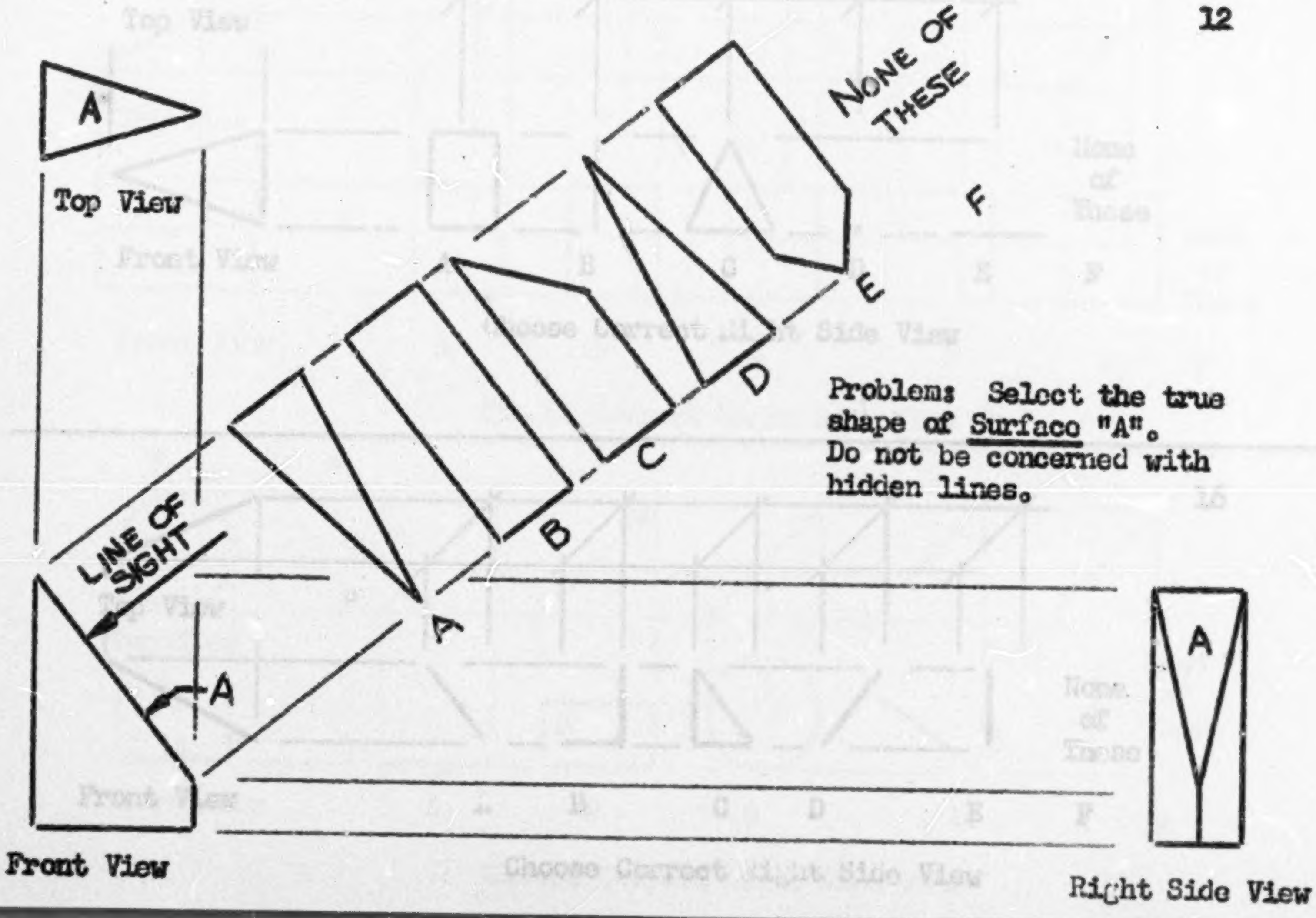
Problem: Select the true shape of Surface "A". Do not be concerned with hidden lines.

11


A
Top View
LINE OF SIGHT
A
Front View
A
B
C
D
E
NONE OF THESE
F
A
Right Side View

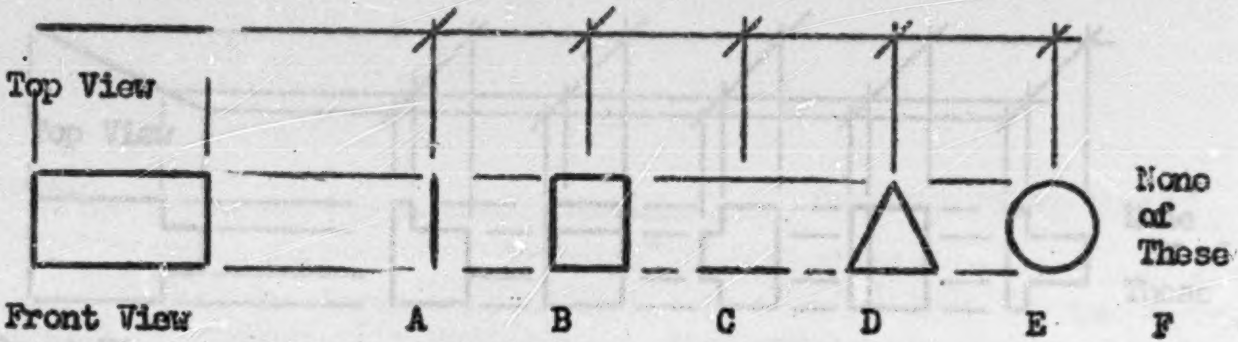
Problem: Select the true shape of Surface "A". Do not be concerned with hidden lines.

12


A
Top View
LINE OF SIGHT
A
Front View
A
B
C
D
E
NONE OF THESE
F
A
Right Side View

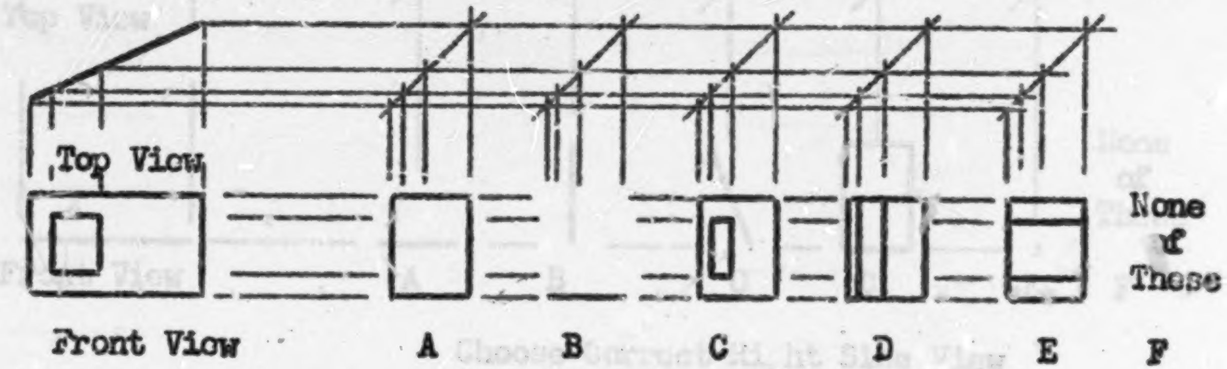
Problem: Select the true shape of Surface "A". Do not be concerned with hidden lines.

13


Top View
None of These
Front View
A
B
C
D
E
F

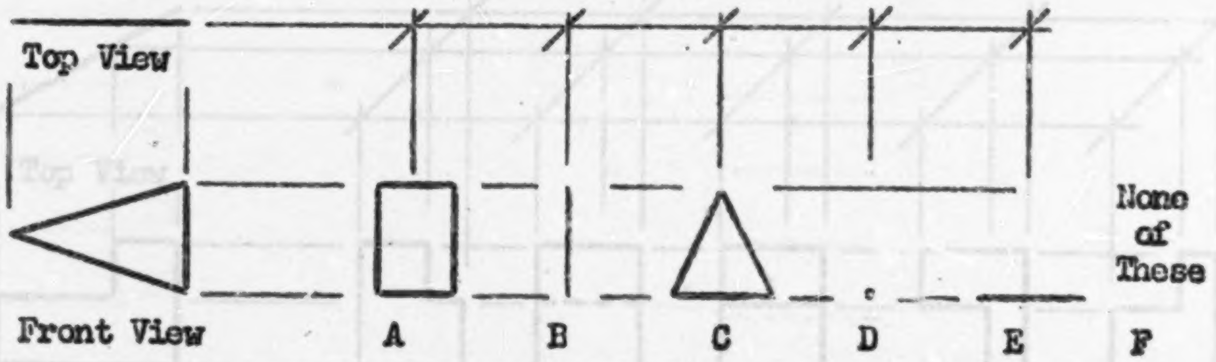
Choose Correct Right Side View

14


Top View
None of These
Front View
A
B
C
D
E
F

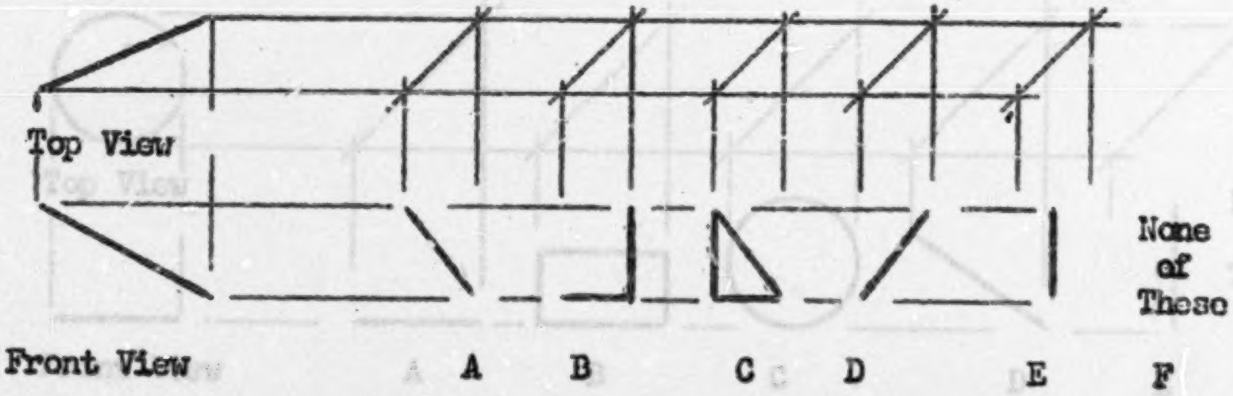
Choose Correct Right Side View

15


Top View
None of These
Front View
A
B
C
D
E
F

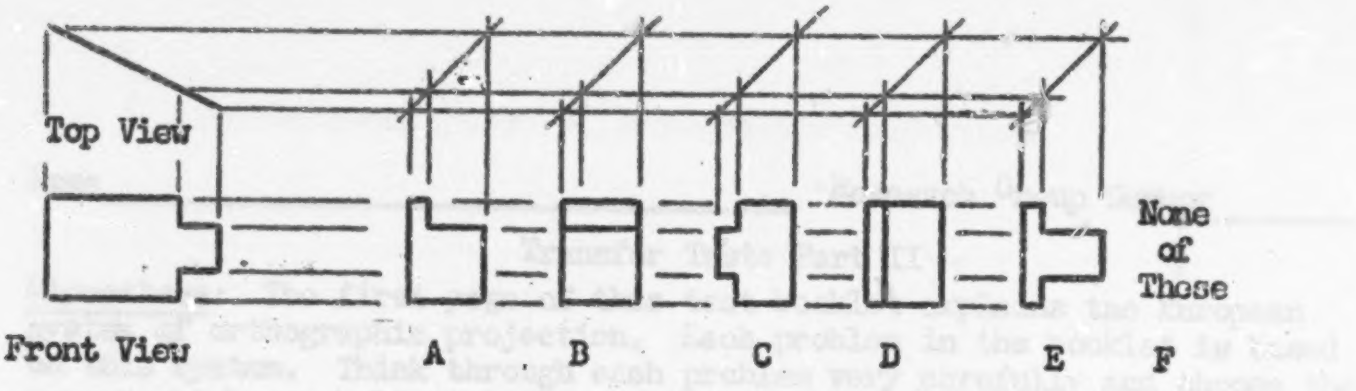
Choose Correct Right Side View

16


Top View
None of These
Front View
A
B
C
D
E
F

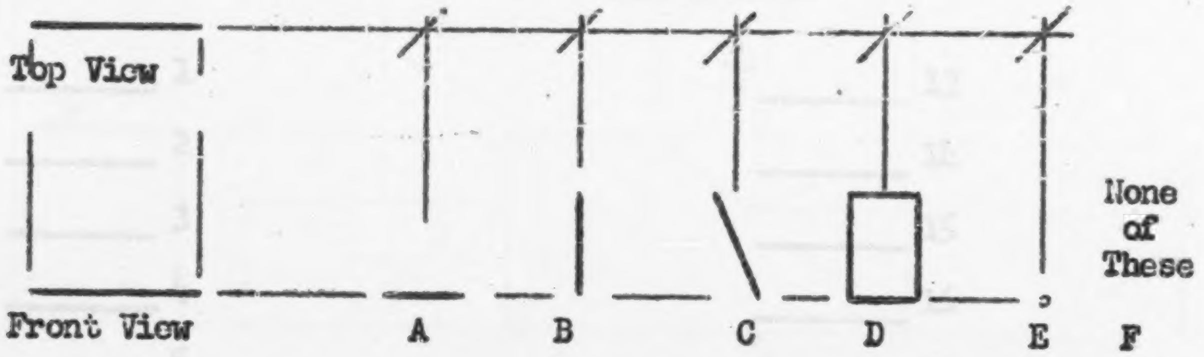
Choose Correct Right Side View

17


Top View
Front View
A
B
C
D
E
None of These
F

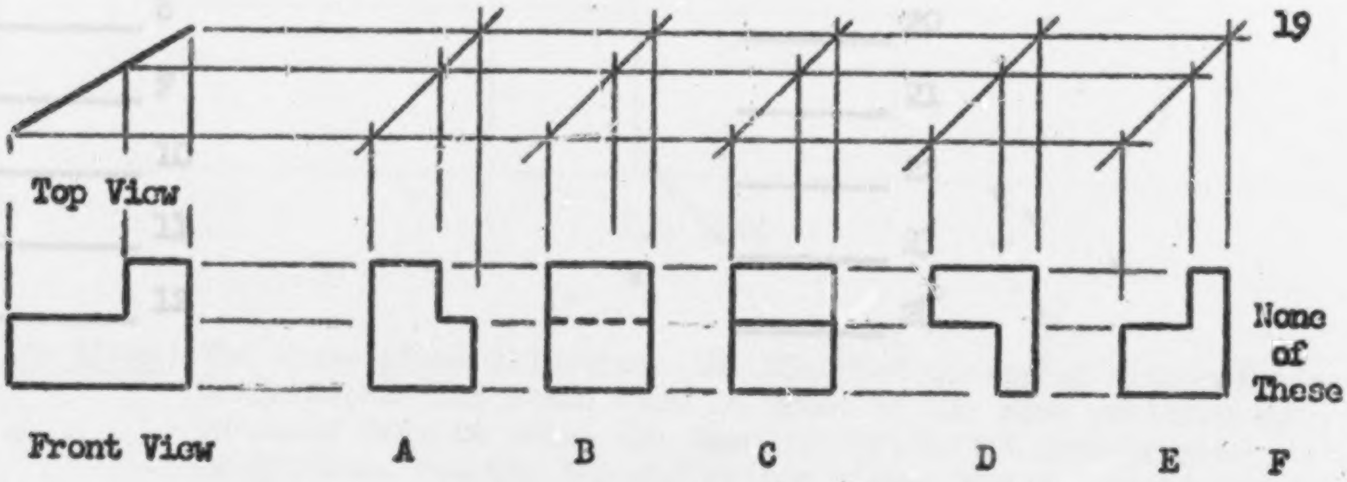
Choose Correct Right Side View

18


Top View
Front View
A
B
C
D
E
None of These
F

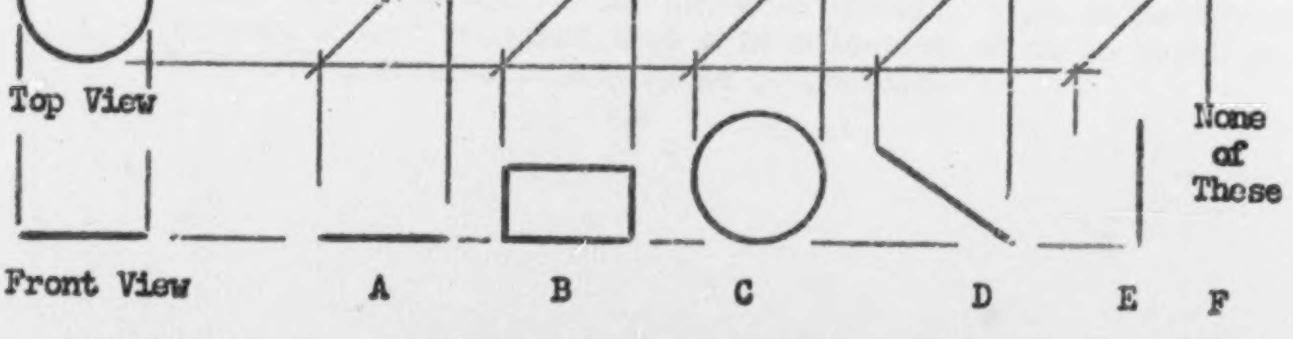
Choose Correct Right Side View

19


Top View
Front View
A
B
C
D
E
None of These
F

Choose Correct Right Side View

20


Top View
Front View
A
B
C
D
E
None of These
F

Choose Correct Right Side View

Name_______________________________ Research Group Number________

Transfer Test: Part II

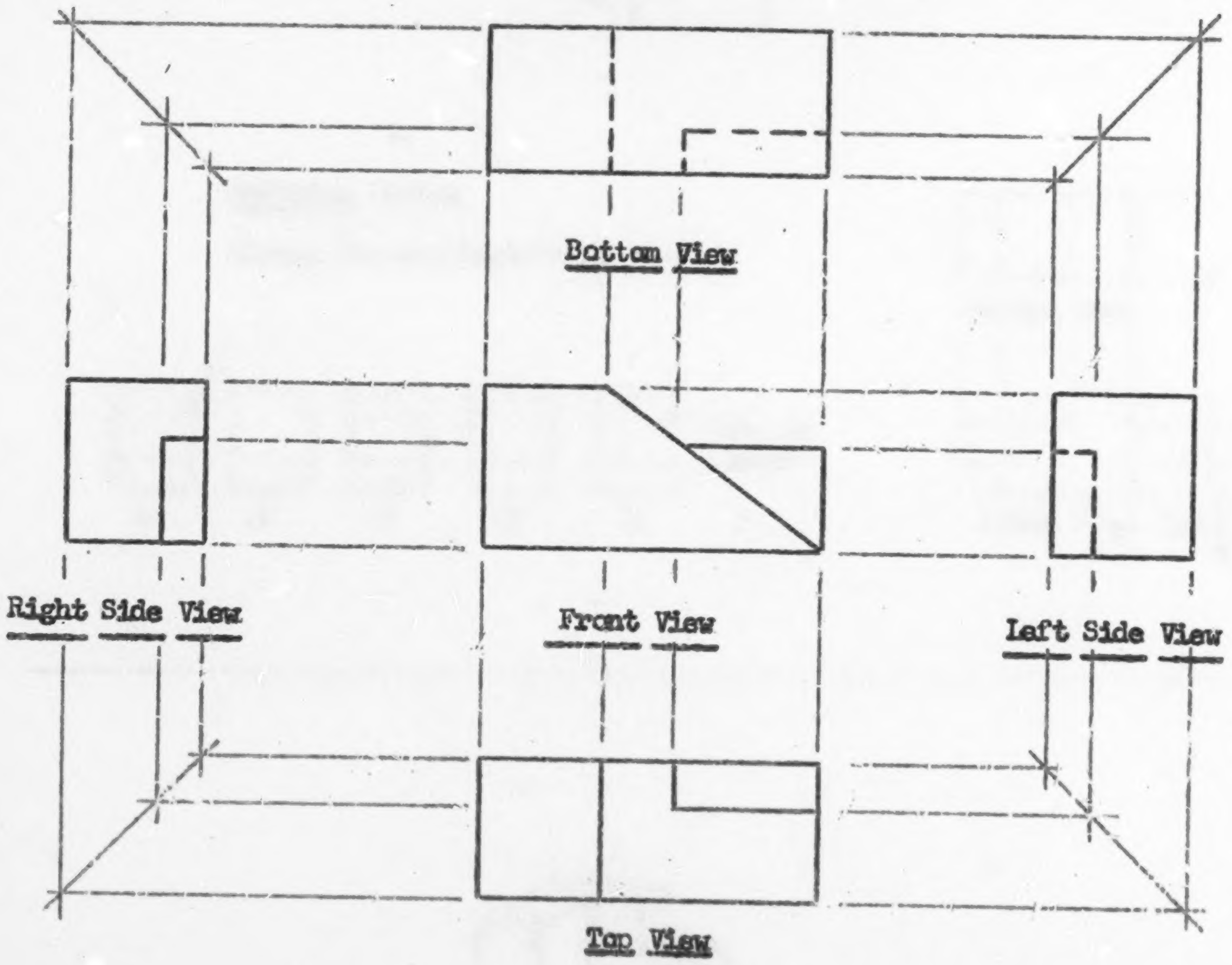
Directions: The first page of this test booklet explains the European system of orthographic projection. Each problem in the booklet is based on this system. Think through each problem very carefully and choose the answer which you believe to be correct. Make a "best guess" in the event that you are uncertain of the answer.

ANSWER SHEET

________ 1
________ 2
________ 3
________ 4
________ 5
________ 6
________ 7
________ 8
________ 9
________ 10
________ 11
________ 12

________ 13
________ 14
________ 15
________ 16
________ 17
________ 18
________ 19
________ 20
________ 21
________ 22
________ 23
________ 24

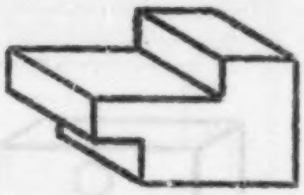
The European System of Orthographic Projection



Directions: The above views illustrate the EUROPEAN system of orthographic projection. The front view is drawn in the same position as we would draw it using the American system of orthographic projection, but the top and bottom views, and the right and left side views are REVERSED in locations. These views are exactly the same as if they were drawn using the American system; only the location or placement of the views differ.

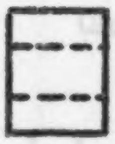
The remainder of the problems which you will be asked to work today will be based on the EUROPEAN system. When selecting an answer, always remember that this selection os to be based on the EUROPEAN system of orthographic projection.

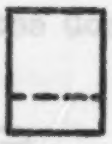
1

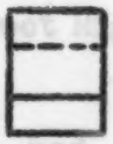


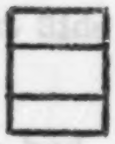
European System

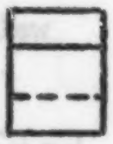
Choose Correct Right Side View


A

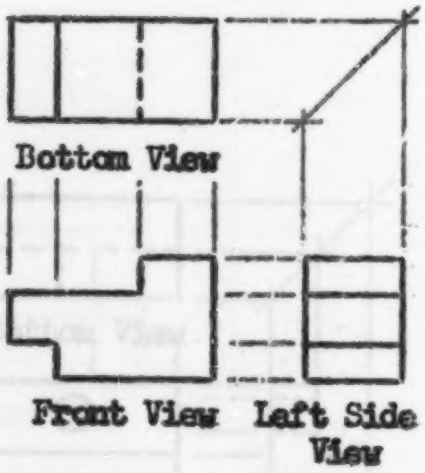

B


C

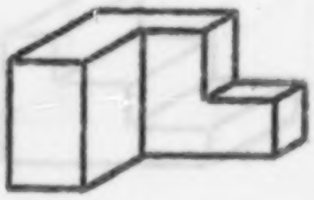

D


E

None of these
F

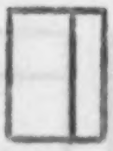

Bottom View
Front View
Left Side View

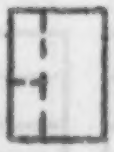
2

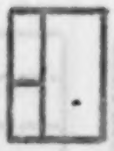


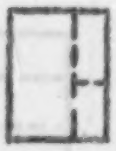
European System

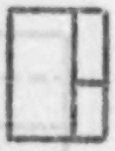
Choose Correct Right Side View


A

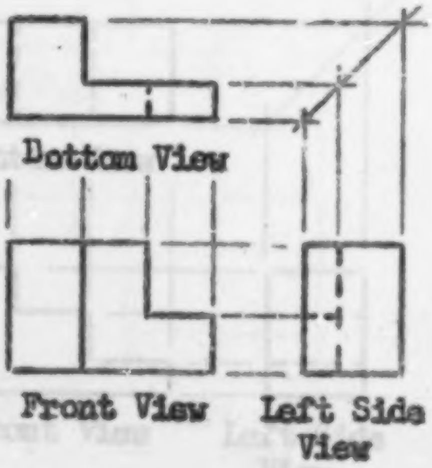

B


C

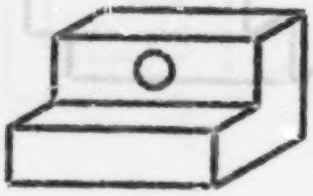

D


E

None of these
F

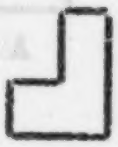

Bottom View
Front View
Left Side View

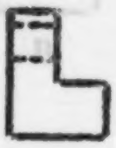
3

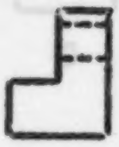


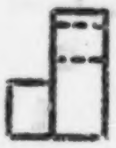
European System

Choose Correct Right Side View


A


B


C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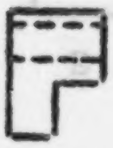
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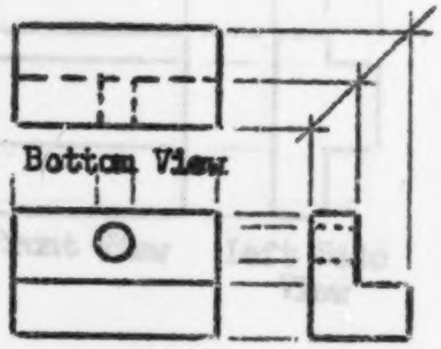
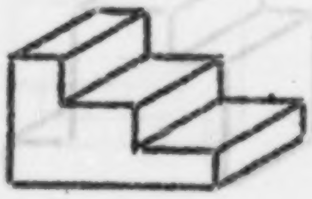
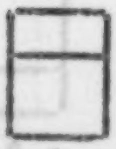

Bottom View
Front View
Left Side View

4



European System

Choose Correct Right Side View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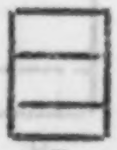
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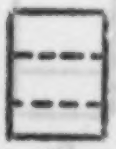
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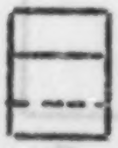
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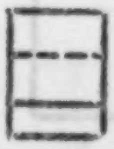
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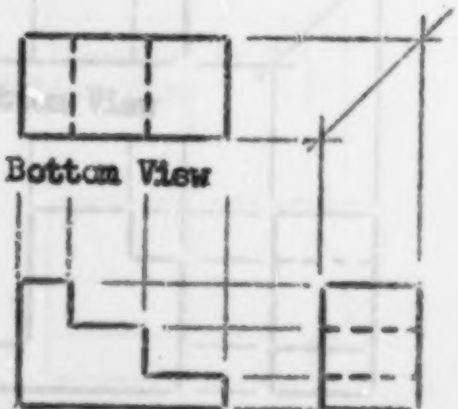
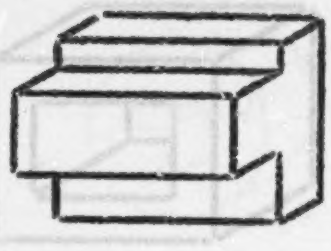
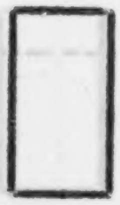

Bottom View
Front View
Left Side View

5



European System

Choose Correct Right Side View



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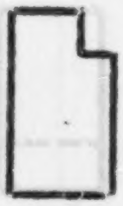

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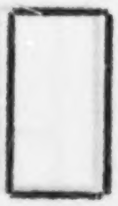

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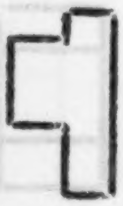

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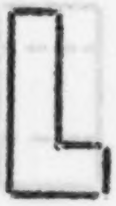

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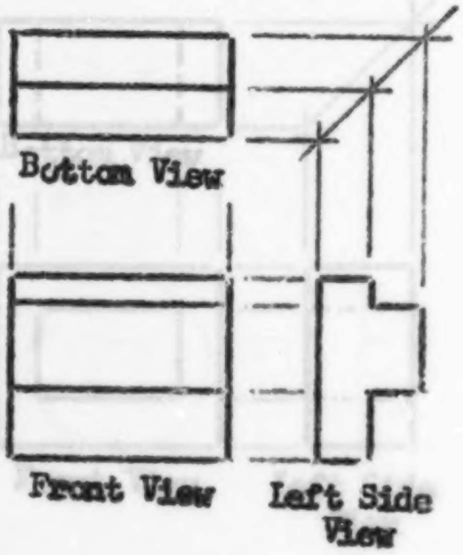
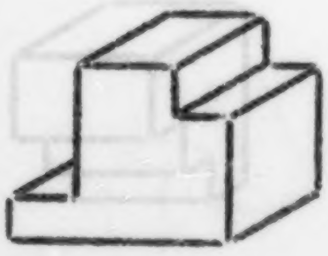
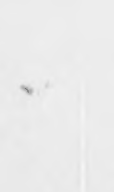

Bottom View
Front View
Left Side View

6



European System

Choose Correct Right Side View



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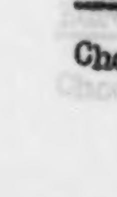

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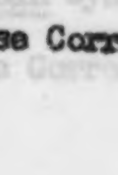

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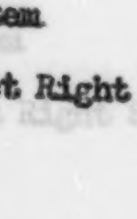

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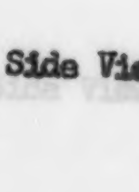

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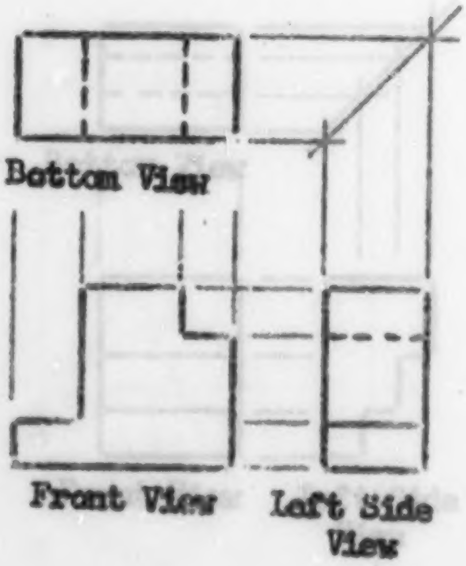
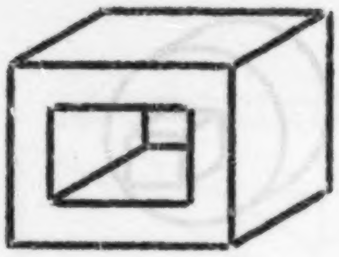
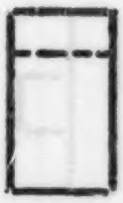

Bottom View
Front View
Left Side View

7



European System

Choose Correct Right Side View



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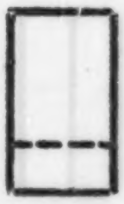

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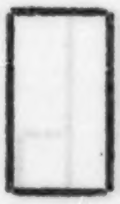

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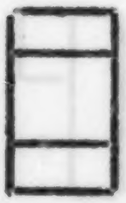

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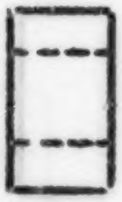

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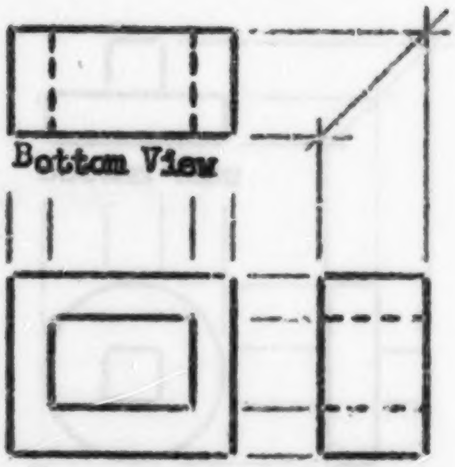
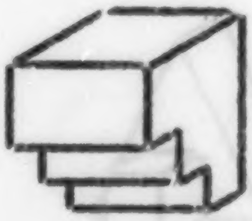
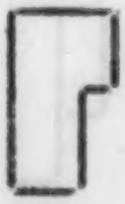

Bottom View
Front View
Left Side View

8



European System

Choose Correct Right Side View



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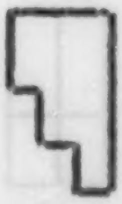

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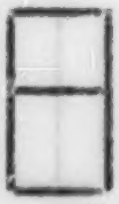

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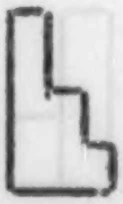

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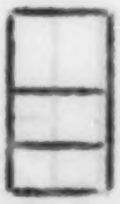

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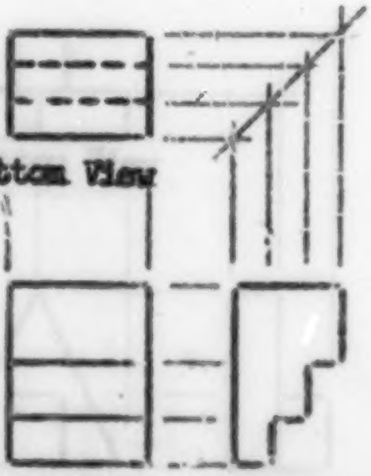
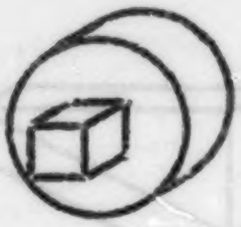
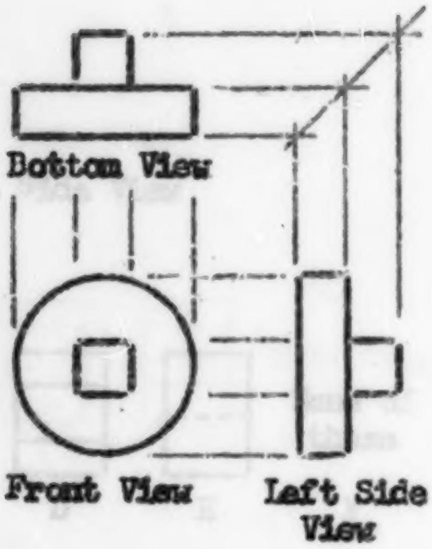

Bottom View
Front View
Left Side View

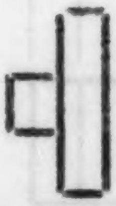
9



European System

Choose Correct Right Side View


Bottom View
Front View
Left Side View



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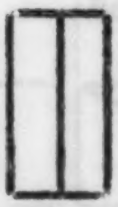

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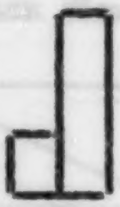

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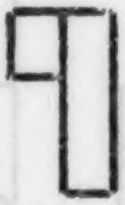

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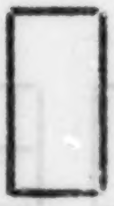

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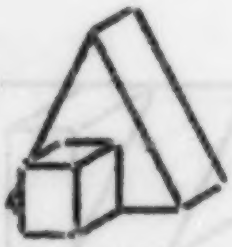
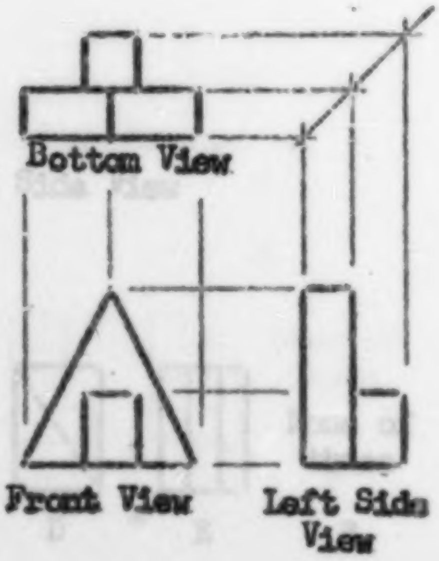
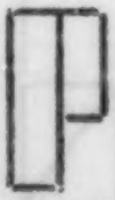
10



European System

Choose Correct Right Side View


Bottom View
Front View
Left Side View



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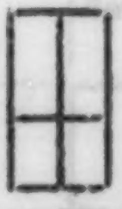

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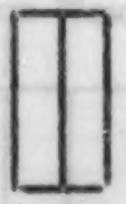

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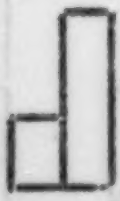

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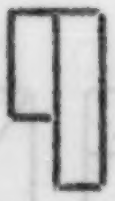

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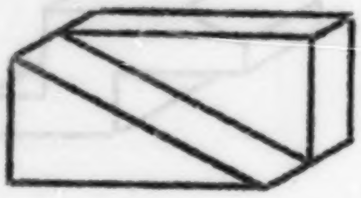
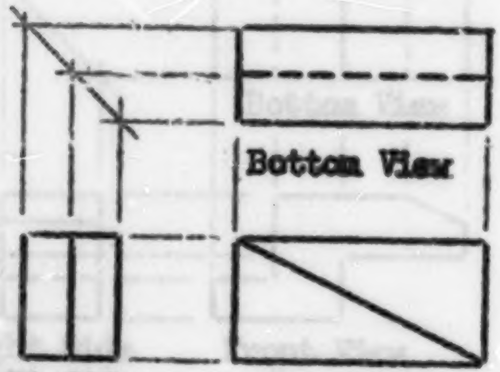
11



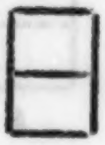

Bottom View

Right Side View

Front View

European System

Choose Correct Left Side View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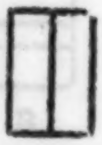
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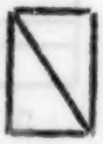
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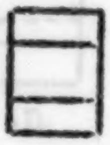
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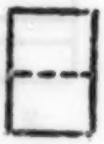
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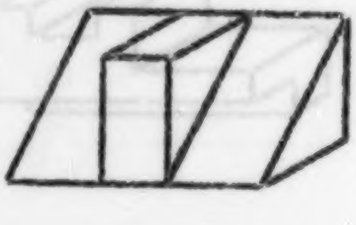
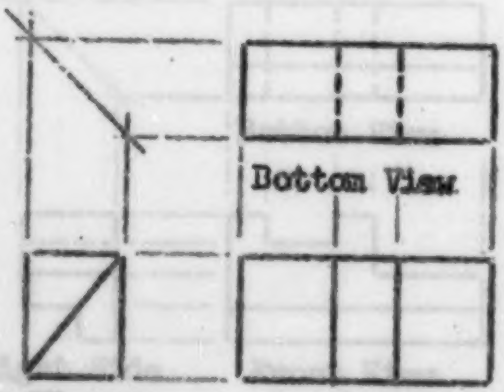
12



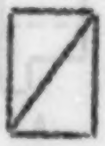

Bottom View

Right Side View

Front View

European System

Choose Correct Left Side View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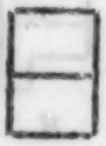
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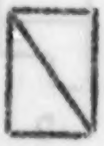
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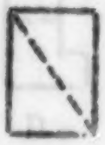
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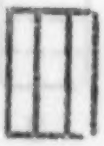
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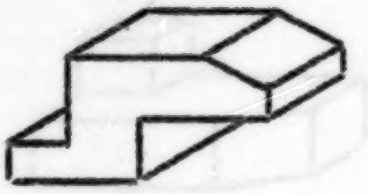
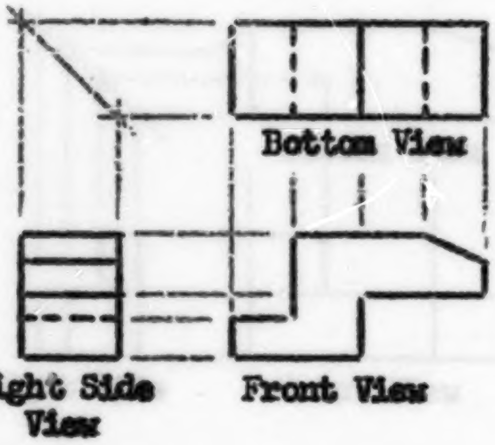
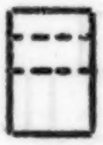
13



European System

Choose Correct Left Side View


Bottom View
Right Side View
Front View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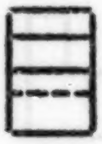
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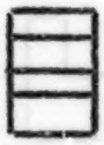
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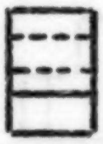
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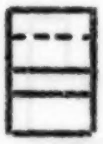
E

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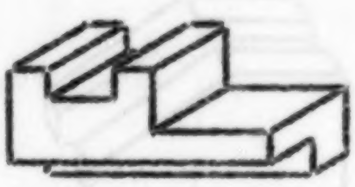
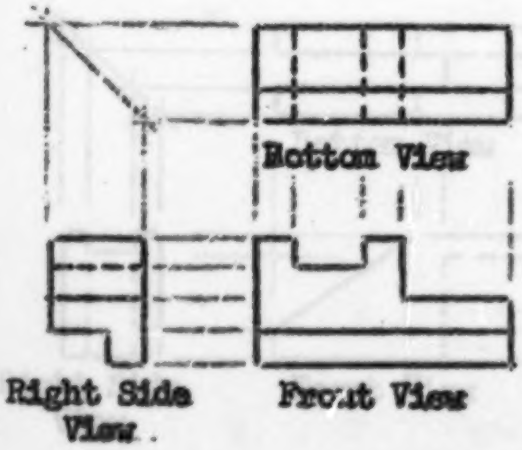
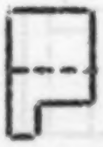
14



European System

Choose Correct Left Side View


Bottom View
Right Side View
Front View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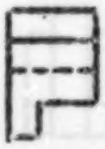
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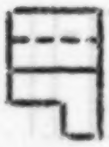
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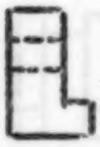
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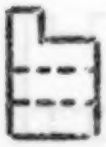
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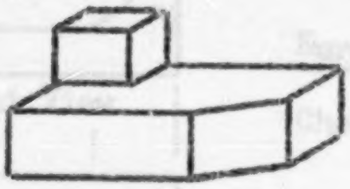
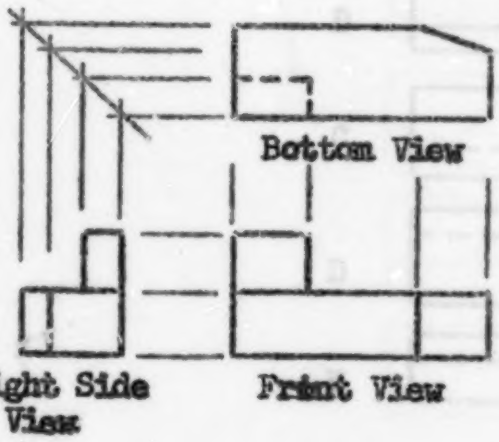
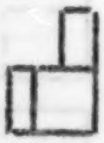


European System

Choose Correct Left Side View


Bottom View
Right Side View
Front View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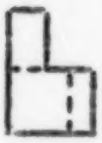
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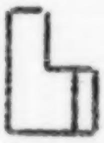
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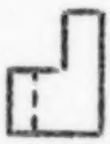
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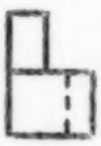
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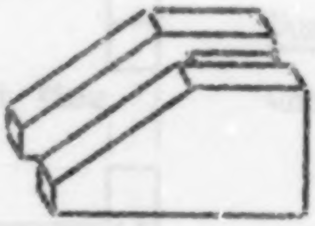
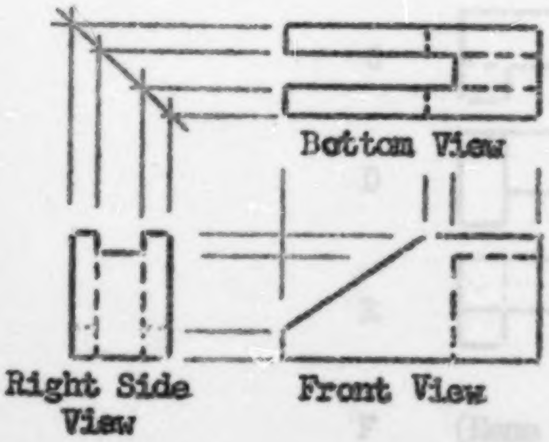
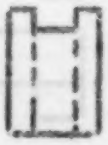


European System

Choose Correct Left Side View


Bottom View
Right Side View
Front View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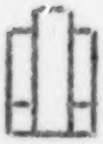
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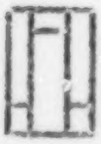
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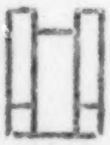
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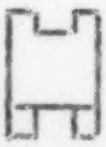
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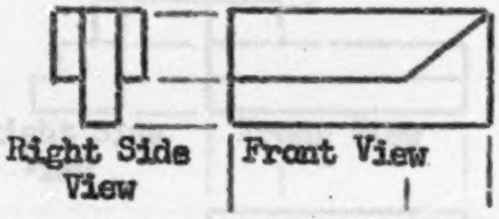
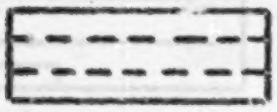
17


Right Side View
Front View

European System

Choose Correct Top View

A


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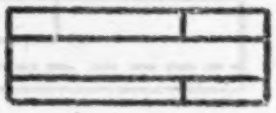

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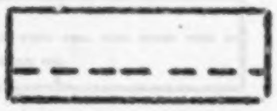

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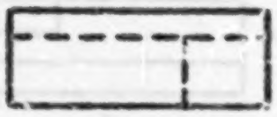

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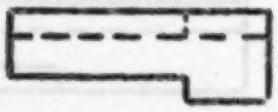

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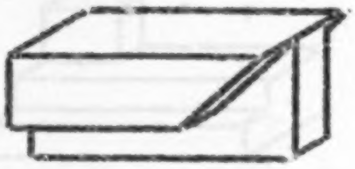

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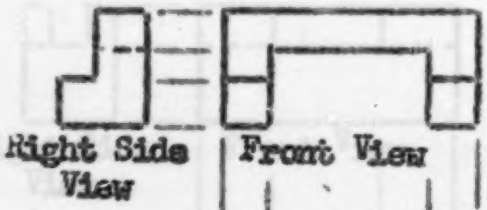
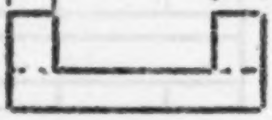

Right Side View
Front View

European System

Choose Correct Top View

A


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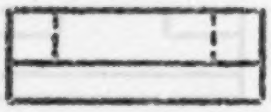

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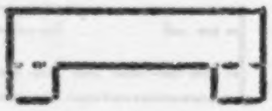

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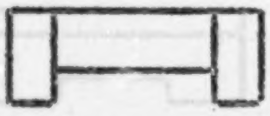

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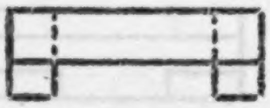

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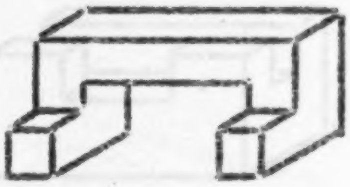
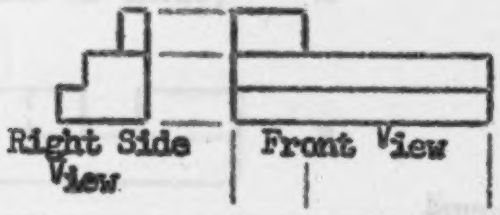
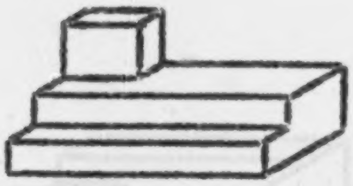


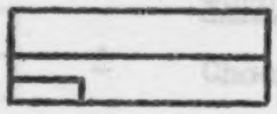
19

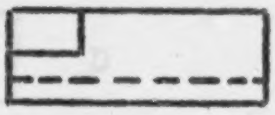

Right Side View
Front View

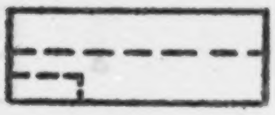
European System

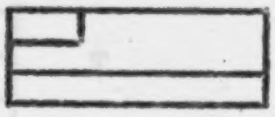
Choose Correct Top View

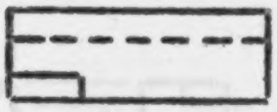


A 

B 

C 

D 

E 

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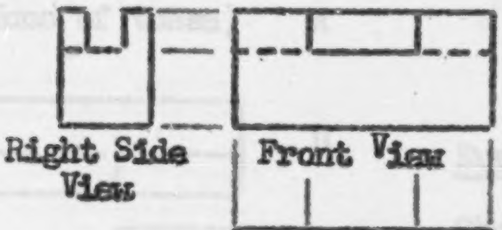
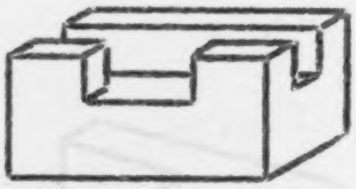
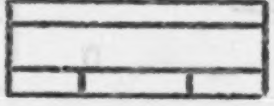
20

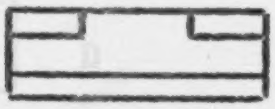

Right Side View
Front View

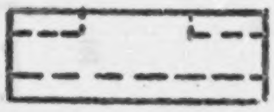
European System

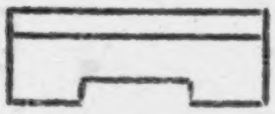
Choose Correct Top View

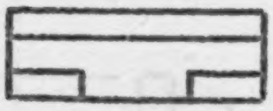


A 

B 

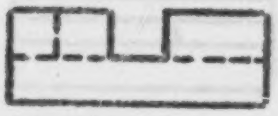
C 

D 

E 

F (None of these)

(None of these) A



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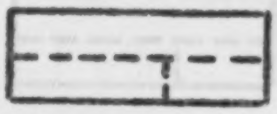

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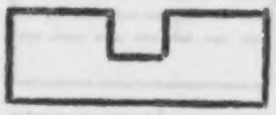

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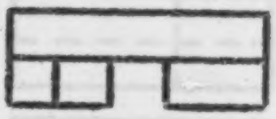

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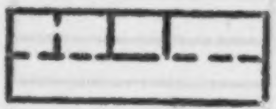
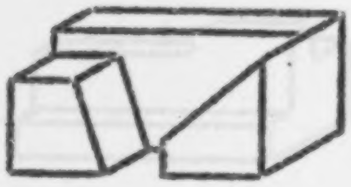
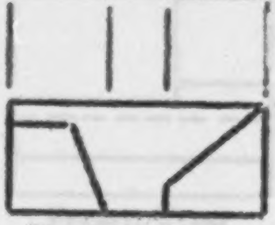


F

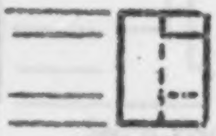
European System

Choose Correct Bottom View





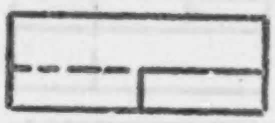
Front View



Left Side View

(None of these) A

22



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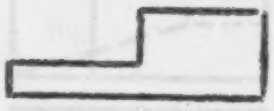

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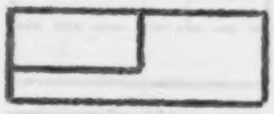

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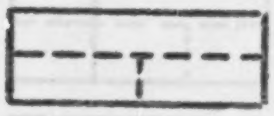

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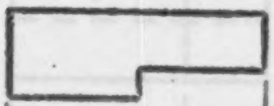
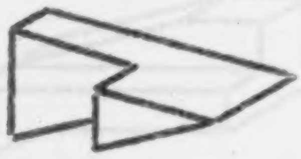
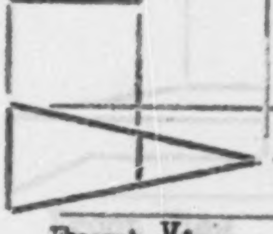


F

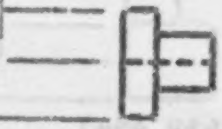
European System

Choose Correct Bottom View





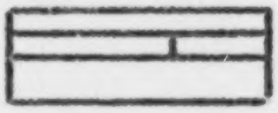
Front View



Left Side View

23

(None of these) A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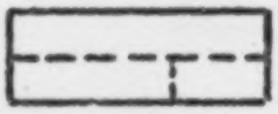
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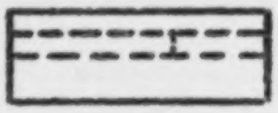
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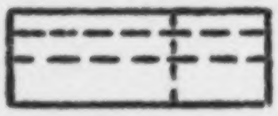
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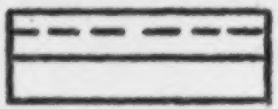
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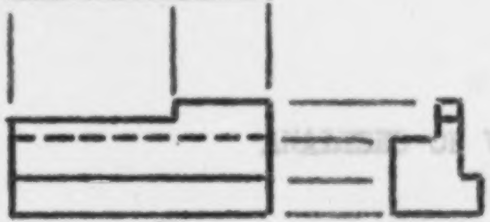
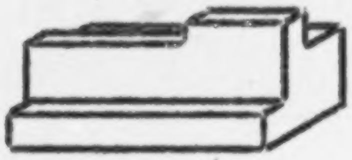

Front View

Left Side View

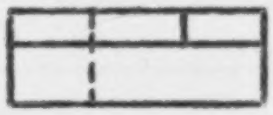
European System

Choose Correct Bottom View



24

(None of these) A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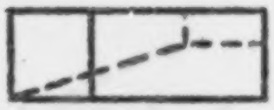
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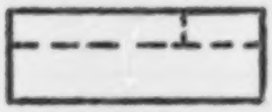
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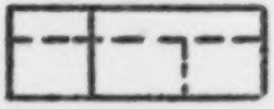
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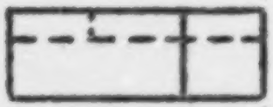
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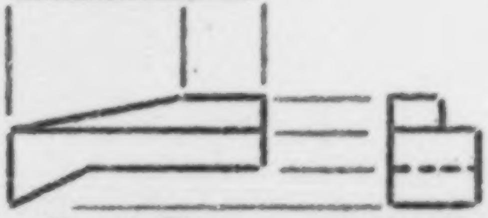
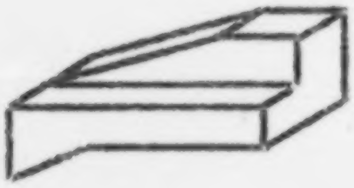

Front View

Left Side View

European System

Choose Correct Bottom View



APPENDIX E

ANALYSES OF VARIANCE OF ATTRIBUTES OF SUBJECTS

TABLE E-1

ANALYSIS OF VARIANCE OF *MINNESOTA PAPER FORM BOARD TEST* SCORES OF SUBJECTS BY TREATMENT

Source	Sum of Squares	df	Mean Square	F
Between	24.48	2	12.24	-
Within	10965.32	144	76.14	
Total	10989.80	146		

TABLE E-2

ANALYSIS OF VARIANCE OF *MINNESOTA PAPER FORM BOARD TEST* SCORES OF HIGH ABILITY LEVEL SUBJECTS BY TREATMENT

Source	Sum of Squares	df	Mean Square	F
Between	1.70	2	.85	-
Within	730.30	46	15.88	
Total	732	48		

TABLE E-3

ANALYSIS OF VARIANCE OF MINNESOTA PAPER FORM BOARD TEST SCORES OF AVERAGE ABILITY LEVEL SUBJECTS BY TREATMENT

Source	Sum of Squares	df	Mean Square	F
Between	1.25	2	.62	-
Within	201.53	46	4.38	
Total	202.78	48		

TABLE E-4

ANALYSIS OF VARIANCE OF MINNESOTA PAPER FORM BOARD TEST SCORES OF LOW ABILITY LEVEL SUBJECTS BY TREATMENT

Source	Sum of Squares	df	Mean Square	F
Between	47.44	2	28.72	1.132
Within	1167.26	46	25.37	
Total	1214.70	48		

APPENDIX F

TEACHING AND TESTING SCHEDULES

TABLE F-1

INSTRUCTION SCHEDULE BY TREATMENT, TIME OF DAY, AND DAY OF WEEK

Day	4:10 - 6:00, Dr. Room A	4:10 - 6:00, Dr. Room B
Monday	A_1	
Tuesday	B_1	
Wednesday	A_2	* C_1
Thursday	B_2	
Monday	B_3	
Tuesday	A_3	

* Control group met for fifty minutes to take the initial learning test

TABLE F-2

TESTING SCHEDULE ONE WEEK AFTER INSTRUCTION BY TREATMENT, TIME OF DAY, AND DAY OF WEEK

Day	4:10 - 6:00, Dr. Room A	4:10 - 6:00, Dr. Room B
Monday		A_1
Tuesday		B_1
Wednesday	A_2	C_1
Thursday	B_2	
Monday	B_3	
Tuesday	A_3	

TABLE F-3

TESTING SCHEDULE SIX WEEKS AFTER INSTRUCTION BY TREATMENT, TIME OF DAY, AND DAY OF WEEK

Day	4:10 - 6:00, Dr. Room A	4:10 - 6:00, Dr. Room B
Monday	A_1	
Tuesday	B_1	
Wednesday	A_2	C_1
Thursday	B_2	
Monday	B_3	
Tuesday	A_3	

APPENDIX G

TEST CORRELATIONS AND INTERCORRELATIONS

TABLE G-1

INTERCORRELATIONS OF TOTAL TEST SCORES OF THE FIVE CRITERION TESTS

N = 126

Test	Initial Learning	Retention One Week	Transfer One Week	Retention Six Weeks	Transfer Six Weeks
Initial Learning		.86	.80	.74	.70
Retention One Week			.82	.81	.73
Transfer One Week				.78	.86
Retention Six Weeks					.79
Transfer Six Weeks					

TABLE G-2

CORRELATIONS OF *MINNESOTA PAPER FORM BOARD TEST* SCORES AND THE TOTAL TEST SCORES OF THE FIVE CRITERION TESTS

Test	Initial Learning	Retention One Week	Transfer One Week	Retention Six Weeks	Transfer Six Weeks
Minnesota Paper Form Board	.51	.61	.54	.51	.49

APPENDIX H

COMPARISONS OF TREATMENTS A AND B WITH TREATMENT C ON THE FIVE CRITERION TESTS

TABLE H-1

A COMPARISON OF TREATMENTS A AND C ON THE FIVE CRITERION TESTS

Test	Treatment A	Treatment C	* *t*-value
Initial Learning	$\bar{X} = 31.38$ $s = 9.971$ $n = 63$	$\bar{X} = 11.52$ $s = 2.926$ $n = 21$	14.10
Retention One Week	$\bar{X} = 32.30$ $s = 11.349$ $n = 63$	$\bar{X} = 12.33$ $s = 3.889$ $n = 21$	12.61
Transfer One Week	$\bar{X} = 22.35$ $s = 7.828$ $n = 63$	$\bar{X} = 17.05$ $s = 3.528$ $n = 21$	4.24
Retention Six Weeks	$\bar{X} = 32.30$ $s = 12.124$ $n = 63$	$\bar{X} = 13.43$ $s = 6.029$ $n = 21$	9.36
Transfer Six Weeks	$\bar{X} = 22.51$ $s = 7.402$ $n = 63$	$\bar{X} = 16.91$ $s = 5.567$ $n = 21$	4.83

* Walker and Lev (34, 157) state that this statistic, when it is unreasonable to assume equal variability and N is large, may be referred to a table of normal probability. A value of 1.96 is significant at the .05 level for directional two-sided tests. All such values entered in the column above greatly exceed this in favor of the Treatment A group.

TABLE H-2

A COMPARISON OF TREATMENTS B AND C ON THE FIVE CRITERION TESTS

Test	Treatment B	Treatment C	* t-value
Initial Learning	$\bar{X}$ = 32.94 s = 9.952 n = 63	$\bar{X}$ = 11.52 s = 2.926 n = 21	15.23
Retention One Week	$\bar{X}$ = 35.65 s = 11.180 n = 63	$\bar{X}$ = 12.33 s = 3.889 n = 21	14.18
Transfer One Week	$\bar{X}$ = 24.06 s = 7.424 n = 63	$\bar{X}$ = 17.05 s = 3.528 n = 21	5.79
Retention Six Weeks	$\bar{X}$ = 35.65 s = 11.476 n = 63	$\bar{X}$ = 13.43 s = 6.029 n = 21	11.37
Transfer Six Weeks	$\bar{X}$ = 25.40 s = 6.683 n = 63	$\bar{X}$ = 16.91 s = 5.567 n = 21	5.74

* Walker and Lev (34, 157) state that this statistic, when it is unreasonable to assume variability and N is large, may be referred to a table of normal probability. A value of 1.96 is significant at the .05 level for directional two-sided tests. All such values entered in the column above greatly exceed this in favor of the Treatment B group.